VICKSBURG DISTRICT
CORPS OF ENGINEERS

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FINAL REPORT

BIOLOGICAL ASSESSMENT OF IMPACTS TO PONDBERRY *(Lindera melissifolia)* RESULTING FROM THE BIG SUNFLOWER RIVER MAINTENANCE PROJECT

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GULF SOUTH RESEARCH CORPORATION

Final Report

Biological Assessment Of Impacts To Pondberry (*Lindera melissifolia*) Resulting From The Big Sunflower River Maintenance Project

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Introduction

This Biological Assessment (BA) discloses and describes the potential effects on the Federally endangered plant, pondberry (*Lindera melissifolia*), that may potentially arise from the Big Sunflower River Maintenance Project.

This BA was prepared by Gulf South Research Corporation (GSRC) for the Vicksburg District, U.S. Army Corps of Engineers (USACE). Section 1 describes the proposed USACE project. The specific area that may be affected by the proposed action is described in Section 2. Section 3 describes the species and any critical habitat that may be affected by the action. The project, history of the project, and the impacts of the proposed project are discussed in Section 4. Section 5 describes the results of the pondberry surveys and the data analysis conducted in 2000. The Yazoo Backwater Reformulation Report and Biological Assessment and their relationship to this BA are described in Section 6. Section 7 presents the conclusions of the BA. Proposed monitoring and research is described in Section 8. References are included in Section 9 and appendices that contain material pertinent to the assessment are included in Section 10.

1.0 Description of the Action to be Considered

The USACE proposes to restore the original design capacity of the Big Sunflower River Maintenance Project completed in the 1960's. The original construction work consisted of channel cleanout, clearing and snagging, and channel diversions. The proposed maintenance work restores the authorized flood control capacity of approximately 133 miles of the original 663 miles of channels. This includes the removal of approximately 8.42 million cubic yards of sediment along 104.8 miles of channel and the clearing and snagging of approximately 28.3 miles of channel. The maintenance work will restore river capacity where it has been diminished due to sediment accumulation primarily through the use of dredging and/or snagging.

The Vicksburg District is in the process of preparing an Environmental Assessment (EA) to update information that has been gathered since the Supplemental Environmental Impact Statement (SEIS) for the Big Sunflower River Maintenance Project which was completed in July of 1996. Since there are known pondberry locations in the project vicinity, a potential exists for this proposed project to affect extant pondberry communities. This Biological Assessment will address the effects of the proposed project on the Federally endangered pondberry.

2.0 Description of the Specific Area that May be Affected by the Action

This section describes the baseline elements of land use, climate, geology, soils, water resources, and biological resources within the Big Sunflower River Basin which approximates Humphreys, Sharkey, Sunflower, Washington, and Yazoo Counties (Figure 1-1). Particular attention will be given to the environmental setting of the Big Sunflower River Basin.

General

The Big Sunflower River is located within the Yazoo River Basin of northwestern Mississippi. The Big Sunflower River has a drainage area of approximately 2,832 square miles. The climate of this region of Mississippi is primarily humid and subtropical with abundant precipitation. The summers are long and hot and the winters are short and mild. The average annual temperature is about 65 degrees F. Average monthly temperatures range from 44 degrees F in January to 82 degrees F in July with extremes ranging from –10 to 110 degrees F. The normal length of the frost-free growing season is slightly longer than seven months.

Average annual rainfall over the area is approximately 51 inches. Normal monthly rainfall varies from 5.81 inches in March to 2.58 inches in October. However, severe rainfall producing locally intense runoff can occur at any time of the year. Snowfall occurs about once a year with an average of approximately two inches.

Physiography

The study area lies in the alluvial valley of the Mississippi River. The topography is characterized by relatively flat, poorly drained land with slopes of 0.3 to 0.9 feet per mile. Elevations range from approximately 120 feet in the northern portions of the project area to 75 feet in the southern portions.

The alluvial valley was formed during the early Pleistocene epoch, or glacial period, at which time the Mississippi River became deeply incised in the coastal plain. During the Quaternary period, the river gradually filled the valley with deposits of sand, silt, clay, and gravel. The deposits generally grade from coarse to fine, proceeding from deep to shallow, with a clay cap typically found on the slopes. This material has been reworked as the streams meandered throughout the area. Depositional features resulting from this activity include abandoned course, abandoned channel, point bar, backswamp, braided streams, and natural levees.

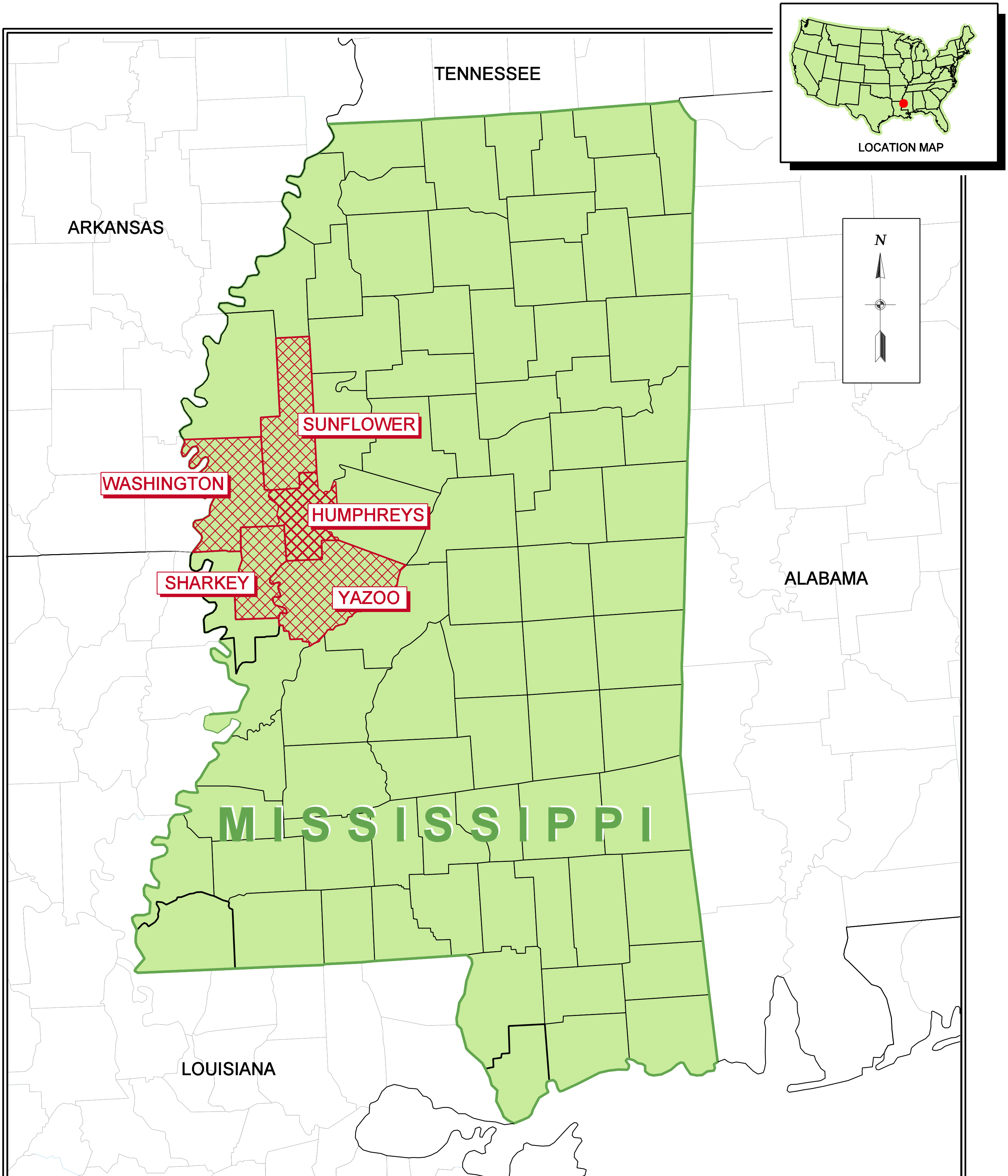

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Figure 1: Project Study Area

SCALE: NOT TO SCALE

DATE: JULY 2001

Project Area

The Big Sunflower River Basin is a mosaic of agricultural land, bottomland hardwoods, swamps, rivers, lakes, and urban areas. The project area includes Delta National Forest (DNF), a 59,000-acre tract of bottomland hardwood forest which is managed by the U.S. Forest Service (USFS).

The Big Sunflower River Basin is part of the lower Yazoo River Basin, as a small representative segment of the lower Mississippi River flood plain. These areas within the Mississippi River floodplain encompass some of the most productive soils on earth. However, the project area is located within the lower reach of the Mississippi River Valley, which is subject to inundation during periods of high water. The alluvial soils of the project area are very fertile, produce excellent agricultural crops, and support vigorous growths of hardwood forests comprised of numerous species adaptable to varying and complex soil and moisture conditions. Better-drained natural levees and ridges with loamy or sandy clay soils support water oak-sweetgum forests (*Quercus nigra - Liquidambar styraciflua*) which also contain several other deciduous species. Extensive flats of slightly lower elevation are occupied by hackberry (*Celtis* sp.), elm (*Ulmus* sp.), ash (*Fraxinus* sp.), and Nuttall oak (*Quercus nuttallii*). Lower lying areas support an overcup oak-water hickory forest (*Quercus lyrata – Carya aquatica*). Wet lake margins, sloughs, and swamps support baldcypress (*Taxodium distichum*), tupelo gum (*Nyssa sylvatica*), willow (*Salix* sp.), and water elm (*Planera aquatica*). Soils in the Lower Mississippi Alluvial Valley are a mosaic of Inceptisols in alluvial bottomland, Alfisols in areas of loess, and Mollisols in areas with swampy vegetation.

3.0 Description of Any Listed Species that May be Affected by the Action

The environmental effects associated with the Big Sunflower River Maintenance Project were originally addressed in a Biological Assessment prepared in July 1996. This document described the potential impacts to pondberry from the Big Sunflower River Maintenance Project. Since 1996, additional surveys have been conducted by the USACE and new information regarding the species profile has been developed. This Biological Assessment will update the 1991 pondberry profile and the 1996 BA (Appendix A) with the most current information. A brief overview of the Endangered Species Act (ESA) and a description of the natural history of pondberry follows.

The Endangered Species Act (ESA) of 1973 (Public Law [PL] 93-205), as amended, was enacted to provide for the preservation of endangered and threatened species and the ecosystems upon which they depend for survival. The ESA requires all federal agencies to implement protection programs for designated species and to use their authorities to further the purposes of the ESA. The Secretary of the Interior, through the USFWS, and the Secretary of Commerce, through the National Marine Fisheries Service (NMFS) are responsible for the identification of an endangered or threatened species and for the development of recovery plans.

Critical habitat is defined in Section 3 of the ESA as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the act, on which are found those physical or biological features (i) that are essential to the conservation of the species and (ii) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

3.1 Pondberry (*Lindera melissifolia*)

3.2 Current Status

Pondberry is currently listed as a Federally endangered species under the Endangered Species Act of 1973. Pondberry was officially listed on 31 July 1986 in the *Federal Register* (51(47):27495-27500). A Final Recovery Plan was completed by the U.S. Fish and Wildlife Service in September of 1993. No critical habitat has been proposed for pondberry. A population has been defined as “one or more colonies that are in close enough proximity to regularly interbreed and separated from other populations by a sufficient distance to preclude interbreeding on a regular basis" (USFWS, 1993). At least 38 populations of pondberry are currently known to exist. Fourteen populations can be found in Mississippi, 10 populations in Arkansas, five populations in Georgia, five populations in South Carolina, three populations in North Carolina, and one population in Missouri (USFWS, 1993).

3.3 Taxonomic Status

Pondberry is a member of the family Lauraceae. It is one of three members of the genus *Lindera* found in the southeastern United States, which also includes common spice-bush (*Lindera benzoin*) and bog spicebush (*L*. *subcoriacea*). Pondberry can be distinguished from the other two members of the genus by its drooping, thin, membraneous, and ovately to elliptically shaped leaves that extrude a sassafras-like odor when crushed.

There are five other genera within the family Lauraceae found in southern U.S. forests: *Persea*, *Ocotea*, *Sassafras*, *Misanteca*, and *Litsea* (Radford et al., 1968; Harrar and Harrar, 1962.)

3.4 General

Lindera melissifolia was first described in 1788 by Walter as *Laurus melissaefolia* in Flora Caroliniana from specimens which he collected within 50 miles of his home in Berkely County, South Carolina.

Early authors easily distinguished *L. melissifolia* from the more common *L. benzoin* (common spicebush). Their descriptions stressed the overall low profile of the plant, shape of the leaves, prominent veination, and pubesescence of the lower leaf surface. However, confusion with *L. benzoin* began in 1864 with DeCandolle's Prodromus 15, part 1:244, in which DeCandolle mentioned a reference by Meissner to a collection of *L. melissifolia* collected by Englemann from Missouri. J.A. Steyermark examined the specimen and found that it was actually a pubescent form of *L. benzoin*, which was later described by Steyermark and Palmer (1935) as *Benzoin aestivale* var. *pubescens* (*Lindera benzoin* var. *pubescens*). The discovery of Meissner's mistaken identification led to the discovery that the pubescent form of *L. benzoin* had frequently and mistakenly been included in *L. melissifolia*. This resulted in an inaccurately large range for the species that include parts of Illinois and Missouri.

In Missouri, *L. melissifolia* was not discovered until 1948 when Steyermark found it in Ripley County. Steyermark referred to pondberry as potentially being "…one of the rarest shrubs in the United States…" based on the extremely low numbers of herbarium specimens. He described the species in 1949 and his description remains one of the most detailed accounts of the morphology and taxonomy of pondberry.

3.5 Nontechnical Description

Lindera melissifolia is commonly known as pondberry, or less frequently as southern spicebush or Jove's fruit. It is a low growing, deciduous shrub ranging in height from 1.5 to 6.5 ft (0.5 to 2 meters) tall. Pondberry typically grows in clumps of numerous, unbranched, scattered stems and reproduces vegetatively by means of stolons. The older portions of the stems are dark green to almost black with numerous, irregularly spaced, but prominent lenticels. The stems appear very similar to saplings or young stems of sassafras (*Sassafras albidum*). The leaves are drooping and range from 0.75 to 2.5 inches (1.9 to 6.35 cm) wide, and 2.0 to 6.5 inches (5.1 to 16.51cm) long with a round to cordate base. The leaves have a distinct sassafras-like odor when crushed. The leaf veins are prominent and the undersurfaces of the leaves are hairy. The small, pale yellow flowers of both sexes are found on separate plants. The flower stalks and buds are often hairy. The fruit is elliptical, bright scarlet red, and about 0.5 inches (1.27 cm) long at maturity. The flowers develop in the spring before leaves emerge (generally in March) with mature fruit evident by October. Fruit stalks are often present until next year's flowering (USFWS, 1992, 1990; Klomps, 1980a; Tucker, 1984).

3.6 Technical Description

The following technical description is taken directly from Steyermark's (1949) description of the species:

> "Low shrub, 0.6 – 2 meters tall: foliage drooping, when crushed with a sassafras-like odor; leaf blade thin, membraneous, oblong, obtuse or round at base. 5 – 16 cm. Long, 2 – 6 cm. Wide, concolorous, slightly to densely pubescent on lower surface; lower surface of blade with conspicuous pronounced veination; lowest two pairs of lateral nerves not parallel to ones above, conspicuously more ascending and diverging from midrib at 45 – 50 degree angle, in contrast to the other lateral nerves which diverge at an angle of approximately 35 degrees; petiole and buds pubescent, 5 – 15 mm long; fruiting pedicels stout, 9 – 12 mm long, conspicuously enlarged at the summit, 2.5 – 3 mm wide; mature fruit (in dried state) elliptic-obovoid, 10 – 11.5 mm long, 7 – 8 mm wide, seed suborbicular, 7 mm long, 6.25 mm wide; winter buds willous; staminate calyx-segments 1 – 1.25 mm long, 1 – 1.25 mm wide: pistillate pedicels 2.5 mm long; fruiting pedicels persistent from previous year and lasting to time of anthesis."

3.7 Geographic Range

Pondberry is presently found in the Mississippi River alluvial plains of Missouri, Arkansas, and Mississippi, and the Coastal Plains region of Georgia, South Carolina, and North Carolina. Historically, pondberry locations have also been reported from Louisiana, Alabama, and western Florida. However these states' populations are now considered extirpated (USFWS, 1993; Tucker, 1984).

3.8 Regional Habitat Requirements

3.8.1 General

The habitat requirements of pondberry appear to be highly variable across its range. In the Mississippi alluvial plains of Arkansas, Missouri, and Mississippi, pondberry occurs on sites with perched water tables and vegetation similar to that of bottomland hardwood habitats. In general, it occupies wetland habitats that are normally flooded or saturated during the dormant season, but infrequently flooded during the growing season for extended periods (Tucker, 1984). The specific habitat types occupied by pondberry have been variously described, e.g. "mesic to hydric sites (i.e., bottomland hardwood habitats, depressions, and margins of sinks and ponds" (Wofford, 1983) and "sandy sinks and pond margins, swamps and pond margins, and swampy depressions (Porcher, 1980). Devall *et. al*. (2000) noted that pondberry has a wide ecological amplitude as long as its requirements for water were met.

These habitat types vary from the edges of limestone sinks in South Carolina to depressions within bottomland hardwoods in Mississippi. Although factors such as associate species and soils may vary across its range, the characteristic of occupying locally depressed or ponded areas is consistent throughout its range. A brief description of the habitat requirements within the other states will be provided; however, the majority of this discussion will focus on the Mississippi populations based on previously published data, as well as field surveys conducted in 1990, 1991 and 1996 by the USACE. The results of the 2000 surveys and subsequent data analysis will be presented in Section 5.

3.8.2 North Carolina/South Carolina/Georgia

a. <u>Habitat</u>

The habitats of pondberry populations within North Carolina and South Carolina are notably different. The North Carolina populations are described as inhabiting areas, "…associated with bay forest or pocosin vegetation (but which has been largely destroyed through fire, resulting in a disclimax composed of more shrubs than formally)" (Tucker, 1984).

The South Carolina populations occupy two habitat types, the margins of limestone sinks and shallow depressions in pinelands. The limestone sinks generally maintain water throughout most of the year by either artesian water or rainwater. Pondberry plants are found on the periphery of these limestone sinks at elevations where normal high water levels occur. The plants are generally free of competing vegetation at these higher levels. The shallow pineland depressions are fed by rainwater often maintaining water for several months. Pondberry generally grows in standing water within these depressions (Porcher, 1980).

Georgia populations of pondberry occur around the borders of sphagnum bogs. One extensive, thriving population, near McRae, Georgia, occurs in a very open area and the colony receives full sun (Devall *et. al*., 2000).

b. Soils

The soils of the North Carolina populations occur on sandy soils with a high content of peat in the subsurface and a high water table (Tucker, 1984). The soils of the South Carolina populations are reported to be very acidic peaty sand with a surface pH of 4.5 and subsurface pH of 5.5. The water table was 29 inches below the soil surface when measured in October (Radford, 1976).

c. Associate Species

Within the bayforest or pocosin habitat of the population found in North Carolina, common tree and shrub associates include redbay (*Persea borbonia*), sweetbay (*Magnolia virginiana*), blackgum (*Nyssa sylvatica* var. *biflora*), pondcypress (*Taxodium ascendens*), red maple (*Acer rubrum*), pond pine (*Pinus serotina*), longleaf pine (*P. palustris*), swamp cyrilla (*Cyrilla racemiflora*), fetterbush (*Lyonia* spp.), bayberry (*Myrica* spp.), blueberry (*Vaccinium* spp.), and greenbriar (*Smilax* spp.) (Morgan, 1983; Tucker, 1984).

The associate species within the limestone sink habitat of South Carolina were documented by Radford *et*. *al*. (1968). The reported tree species within the sinks are pondcypress and blackgum. The dominant tree species around the sink's edge include loblolly pine (*Pinus taeda*), water oak, laurel oak (*Quercus laurifolia*), live oak (*Q. virginiana*), and sweetgum. Associate shrub species within the sinks include dahoon holly (*Ilex cassine*) and pondspice (*Litsea aestivalis*), while additional associate species on the sink's edge include southern wax-myrtle (*Myrica cerifera*), black high blueberry (*Vacciniuum atrococcum*), St. Andrew's cross (*Hypericum hypericoides*), St. Peter's-wort (*H. stans)*, inkberry (*Ilex glabra*), American holly (*Ilex opaca)*, and staggerbush (*Lyonia marione*). A common associate in the pineland depressions habitat of South Carolina is the marsh fern (*Woodwardia virginia*) (Porcher, 1980).

Tree species present at one Georgia population include maple (*Acer* sp.), sweetgum, and loblolly pine (Devall *et*. *al*., 2000).

3.8.3 Missouri/Arkansas

The Missouri and Arkansas populations are considered, historically, to have been a single contiguous population. However, habitat destruction and alteration have resulted in two disjunct units (Tucker, 1984; USFWS, 1993). Due to the similarity of their habitats and historical relationship, the two populations are discussed together.

a. <u>Habitat</u>

The pondberry populations of Missouri and Arkansas are found in swampy depressions within swales between sand dunes of the Mississippi River alluvial valley (USFWS, 1990). This ridge and swale topography was formed during the Wisconsin Stage glaciation by braided streams which carried glacial outwash (Saucier, 1978). The dunes range from two to 10 feet higher than the depressions. These depressions often form drainage nets which, in turn, form natural swamps and ponds. These areas may hold up to 20 inches of water during spring, but are normally dry by October. Pondberry grows in these depressions or swale areas on level ground under a closed canopy of bottomland hardwood species (Klomps, 1980a).

b. <u>Soils</u>

Tucker (1984) reported that the soils within these swales in Arkansas and Missouri are normally loams or silty loams. Several of the pondberry colonies are found on soils which have an elevated calcium and magnesium ion exchange complex in the soil subsurface. The soils are acidic as evidenced by the occurrence of mosses such as *Climacium* spp., *Polytrichum* spp., and *Leurobryum* spp. (Klomps, 1980b). Pondberry populations are found on sites composed of Boskett-Tuckerman Series (Allgood and Persinger, 1979) with Ordovician dolomites as the primary underlying geologic substrate. The soil associations in these areas are also characterized by high water tables and poor drainage (Tucker, 1984).

c. Associate Species

Pondberry typically occupies the depressions or lower side slopes while common spicebush (Lindera benzoin), is found on the higher, adjacent, nonflooding ground. The tree species frequently associated with pondberry in Arkansas and Missouri are pin oak (*Quercus palustris*), Nuttall oak, willow oak (*Quercus phellos*), cherrybark oak (*Quercus falcata* var. *pagodaefolia*), overcup oak, pumpkin ash (*Fraxinus tomentosa*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), Drummond's Red Maple (*Acer rubrum* var. *drummondii*), sweetgum, and common persimmon (*Diospyros virginiana*) (Klomps, 1980b; Tucker, 1984). Common shrub, herbaceous, and vine associates in Missouri have been reported to include greenbriar (*Smilax glauca*), lizard's tail (*Saururus cernuus*), Virginia sweetspire (*Itea virginica*), false-nettle (*Boehmeria cylindrical*), impatiens (*Impatiens* spp.), wild geranium (*Geum* spp.), sedge (*Carex* spp.), bedstraw (*Galium* sp.), bitter cress (*Cardamine bulbosa*), plum (*Prunus* spp.), and ironwood (*Carpinus caroliniana*) (Klomps, 1980b).

3.8.4 Mississippi

a. Habitat

Tucker (1984) reported that pondberry populations in Mississippi are associated with "…mature bottomland hardwood forests in low depressions." Populations are currently known to exist in the Delta Region of West-Central Mississippi. The habitat of pondberry here is similar to that in Arkansas and Missouri (USFWS, 1990). The USACE (1991a) reported that pondberry colonies in Mississippi are typically found on slight ridges in a ridge and swale community that are either frequently or periodically flooded or is in proximity to a permanent waterbody. The extant populations in Mississippi are associated with bottomland hardwoods at elevations where rainfall/local hydrology dominates the hydrologic conditions at the pondberry colony site. According to the 1996 BA (USACE, 1996), Mississippi populations on the Delta National Forest (DNF) are shade tolerant and found at elevations ranging from the 0-2-year floodplain to the 15-20-year floodplain of the lower Big Sunflower River. The major population of pondberry on the DNF occurs in the Red Gum Research Natural Area. The Red Gum Research Natural Area is a remnant of virgin forest which is slightly higher in elevation than most of the DNF and is only occasionally flooded (Devall *et*. *al*., 2000).

b. Soils

The Mississippi populations are most frequently found on soils characterized by the Sharkey-Alligator-Dowling Association and less frequently on soils characterized by the Alligator-Dowling-Forestdale Association as delineated by the Natural Resource Conservation Service (NRCS) soil survey maps of Sharkey County, Mississippi. These soil associations are very similar with both being found on level, poorly drained soils in slackwater areas and depressions. The Alligator-Forestdale-Forestdale Association can also be found on old natural levees (Soil Conservation Service, 1962). The soils within these associations all have poor drainage, high water tables, low permeability rates, and gleyed B and C horizons (Tucker, 1984; Banker and Goetz, 1989). The tight clay subsoils of these associations results in slow permeability rates (0.2 – 0.6 in/hr. near the surface and 0.06 in/hr. in subsoils). Therefore overland sheet flow dominates water movement in these soils (Banker and Goetz, 1989).

The USACE (1991a) reported that of 44 pondberry colonies surveyed, 41 percent were located in surface soils classified as silty clay, 32 percent in silty clay loams, and 21 percent in silt loam soils. This indicates that pondberry colonies will not likely be found on strictly heavy Alligator, Sharkey, or Dowling clay soils. Extant pondberry colonies are found on soils with a mixture of heavy clays and lighter soils.

c. Associate Species

Common associate species reported for Mississippi populations include tree species such as oaks (*Quercus* spp.), sugarberry, American elm, green ash (*Fraxinus pennsylvanica*), hickory and pecan (*Carya* sp.), etc. (Morgan, 1983; Tucker, 1984).

The USACE (1991a), through data collection from 44 colonies in Mississippi was able to more clearly define associate tree and shrub species. The most common overstory species, in decending order of frequency that were reported from the Mississippi colonies include: oaks (willow, Nuttall, and overcup oak), sweetgum, and elms (cedar elm (*Ulmus crassifolia*), American elm, and winged elm (*Ulmus alata*). The most frequent associate understory species are sweetgum and sugarberry. Common species in the shrub layer, in descending order of frequency include snowbell (*Styrax americana*), deciduous holly (*Ilex decidua*), sugarberry, red maple, green ash, elm, roughleaf dogwood (*Cornus drummondii*), oaks, palmetto (*Sabal minor*), elderberry (*Sambucus canadensis*), common persimmon, red mulberry (*Morus rubra*), and sweetgum.

3.9 Ecology and Life History

3.9.1 Population Biology

Pondberry populations are generally associated with the shade of a mature forest and may be shade dependent (Klomps, 1980a; Tucker, 1984). Pondberry has been reported to be stunted when growing if full sun (USACE, 1996); however, Devall *et*. *al*. (2000) reported that one population near McRae, Georgia is thriving despite the plants growing in a very open area and receiving practically full sun. Field investigations have indicated that vigorous healthy colonies were found in homogeneous clumps with shrub associates growing adjacent to but not within the clumps. In less vigorous colonies, shrub/vine associates were usually growing within the clumps.

Individual stems within each colony are short-lived, generally dying by their seventh or eighth year. Young stems sprout from the rootstock and replace the dying stems. Over time, colonies may expand vegetatively resulting in many vastly rooted stems. A typical vigorous colony, thus, is composed of numerous relatively tall stems, dead and dying stems, as well as young leaf sprouts. There is little record of new seedling establishment and growth; therefore, colony expansion is suspected to be purely vegetative (Tucker, 1984; USFWS 1990).

3.9.2 Reproductive Biology

Individual stems of pondberry begin flowering by their third year of growth (Tucker, 1984). Flowering begins in late February to early March in Mississippi and generally lasts no longer than two weeks. Pondberry is dioecious (male and female flowers on separate plants). A typical colony in Mississippi is composed primarily of male stems with a few to several female stems. In some instances, the entire colony is composed of male plants. In general, seed production in relation to the total number of stems is low. Because flowering occurs in late February to early March, frost or near freezing temperatures often damage flowers, thereby reducing fruit production even more. Rayner and Ferral (1988), in a study of 73 colonies from the Honey Hill region of South Carolina, reported that only 22 percent of all colonies surveyed produced fruit, with fruit production averaging only 22 fruits per colony. They also noted that fruit production did not seem to improve with plant health since sexual reproduction appeared to be poor even in large, healthy plants.

Few details are known about pondberry's reproduction. Pondberry is suspected to be insect pollinated. Tucker (1984) noted small bees and flies on flowers when observing plants in

Arkansas. The fruit contains many oils and similar compounds, which are suspected to make the fruit unpalatable to most wildlife. Therefore, seed dispersal is likely accomplished by seeds merely falling to the ground or by animals picking the fruit and depositing elsewhere (USFWS, 1990). Extremely rare occurrences of seedlings have been documented in the wild. Seed germination beneath parent plants was reported as being successful if the seeds were depressed beneath the soil surface (USFWS, 1993; Wright, 1989). In addition, cleaned and stratified seeds have been reportedly germinated by McCartney (in litt.) as reported by the USFWS (1993). No hybrids are currently known to occur with pondberry.

3.10 Threats and Reasons for Species Decline

Several authors have discussed the reasons behind the suspected decline of pondberry throughout its range. There are no literature records of pondberry's historic abundance. However, apparent reasons for pondberry's current endangered status have been documented, as discussed in the following paragraphs.

Alteration and Habitat Loss

The most critical threat to pondberry, as with many endangered species, is the alteration/modification and/or loss of habitat. Three factors, which constitute this threat, are certain timber harvesting practices, certain drainage activities, and land clearing operations for agricultural, commercial, and private development (USFWS 1990). Various problems are associated with timber-harvesting activities such as heavy equipment crushing plants, felled trees crushing plants or uprooting adjacent trees, opening closed or dense forest canopies, and possible changes in local hydrology. Kral (1983) reported that single-tree selection harvesting in hardwoods would likely not affect pondberry, while clear-cut harvesting, which would result in increased surface water runoff, could potentially increase flood water levels to a detrimental degree. Within the Delta National Forest in Mississippi, the U.S. Forest Service, along with the USFWS, determined that a 100-foot undisturbed buffer around known pondberry colonies along with a 40-acre size limit on clearcut openings would prevent any major changes in hydrology and maintains an adequate crown closure around a colony (Baker and Goetz, 1989).

Several authors have made general statements about drainage activities and subsequent effects on pondberry such as ditching which could reduce the surface and/or groundwater regime in a manner that could reduces the plant's vigor or possibly eliminate it from an existing site (USFWS, 1993). The USACE (1991b) through extensive field studies of pondberry within

Mississippi and consultation with various experts, determined that activities which significantly alter the local hydrological regime of depressions, ponds, sink, or other areas governed by localized hydrology would adversely affect pondberry colonies.

The third factor associated with the loss of habitat is land clearing due to agricultural interests and other developments. Throughout pondberry's range, bottomland hardwoods and similar habitats have been extensively cleared. Within the Mississippi River alluvial valley, bottomland hardwoods decreased 56 percent from 11.8 million acres in 1937 to 5.2 million acres in 1978 while agricultural/croplands increased nearly five million acres during the same time period (USFWS, 1979). Habitat loss alone appears to be a major factor in the current endangered status of pondberry.

Disease/Predation

The literature indicates that nearly all colonies of pondberry are affected by stem dieback. Rayner and Ferral (1988) reported that stem dieback and predation were two factors that lead to poor colony health in the Honey Hill region of South Carolina. Stem dieback has been hypothesized to be fungal and/or drought related but could be characteristic of the species. Predation has been observed by deer and insects, mainly the spicebush swallowtail caterpillar (Rayner and Ferral, 1988; USACE, 1991a). Devall *et*. *al*. (2000) found six insect species in association with pondberry, but none of them appear to be a limiting factor for the plant.

Through field studies of pondberry colonies in Mississippi, stem dieback and insect damage seems to influence the general health of many colonies (USACE, 1991a). McDearman (unpublished data, U.S. Fish and Wildlife Service, e.g. USACE, 1996) monitored substantial dieback and plant mortality during 1991-1993 at a study site in DNF. Devall *et al.* (2000) reported dieback of 33 percent of the stems during June at a site in Shelby County, Mississippi. The best available information seems to indicated that stem dieback is related to fungal pathogens, drought, and the interactions between pathogens and drought. In addition, Devall *et. al*. (2000) noted that in unusual conditions stem dieback may be caused by winter freezing. McDearman (1993) reported that within certain morphological constraints, stem dieback on pondberry can be a natural process of senescence. Subsequent monitoring and studies of plant growth and decline (unpublished, U.S. Fish and Wildlife Service, e.g. USFWS, 2000a) at colonies in DNF found that most instances of stem dieback were accompanied by abnormal patterns of sudden leaf wilt and death during the growing season on plants of all size-classes. This pattern was not indicative of senescence and dieback of old or large plants.

Dead stems have been reported at various locations in different pondberry locations, Wright (1989a) first reported leaf senescence, summer leaf fall (facultatively deciduous), and twig dieback on pondberry plants in response to summer drought conditions in Arkansas. In DNF, the pathological symptoms of active dieback were directly observed and monitored by McDearman at 10 pondberry colonies (USFWS 2000b). The first symptoms were characterized by rapid leaf-wilt and sudden death of leaves and stems, during a late summer dry period, without leaf abscission. Stem, branch (more than one stem), or whole plant death followed during the subsequent fall and winter. Since leaves died rapidly in the summer without abscission at the DNF sites, additional investigations by Dr. Douglass Boyette (USDA Agricultural Research Service) revealed several potential pathogens, including *Diaporthe* sp., the cause of stem-canker.

Browsing by vertebrates appears to occur only occasionally. Some stems were reported to be eaten by rabbits during the winter (Wright, 1989). The USACE (1991a) reported evidence of herbivory at only one of 44 pondberry colonies in the Delta National Forest.

Lack of Reproduction

Recent accounts and studies of pondberry list poor sexual reproductive success as another important reason in the decline of pondberry colonies. Many of the colonies studied in Mississippi consisted mainly of male plants and some entire colonies contained only male stems. Consequently, colony expansion is suspected to occur primarily vegetatively. Sexual reproduction can be accomplished in a controlled environment (such as a nursery) as reported by the USFWS (1990), which indicated successful seed germination when seeds were depressed below the soil surface. During field surveys of the Mississippi population on the DNF, numerous apparently viable seeds were observed on plants although no germination from the previous year's fruits was observed. With the abundance of suitable habitat within DNF, it is likely that if germination and sexual reproduction can occur in the wild, it could be occurring there. However, reports by Tucker (1984) and Morgan (1983) indicated that germination and new seedling establishment may not occur in the wild. Therefore, maintenance and increases of extant populations without man's intervention may depend on expansion of established clones.

However, long term monitoring of known colonies and adjacent areas is needed to determine if new seedling establishment occurs.

Other Reasons For Decline

Other potential reasons for decline such as grazing and trampling by cattle and hogs, changes in climatic conditions, and sever winter stress have been noted in Missouri and Arkansas populations (*Federal Register* 51(147):27495-27500; USFWS, 1990). Sites in both Georgia and Arkansas are being adversely impacted due to trampling by domestic livestock (cattle and hogs) in nearby pastures.

In addition, a weevil (*Heilipus squammosus*) has been found to be associated with the dying twigs on pondberry which may have some effect on pondberry (USFWS, 1993). Devall *et*. *al*. (2000) found that this weevil may provide for an opening for disease, but due to the rarity of this weevil and the common occurrence of dying twigs of pondberry, *H. squammosus* probably does not play a significant role. Further evaluation is required to fully understand the relationship.

4.0 Project History

Following the 1927 flood of the Mississippi River, the Federal Government initiated the Flood Control Act of 15 May 1928. Subsequent legislation modified the 1928 Act and resulted in the development of the Mississippi River and Tributaries Project. Included in this project were three major projects that affected the Yazoo River Basin:

1. Yazoo Backwater Project – authorized by the Flood Control Act of 18 August 1941; provided protection against backwater floods of the Mississippi River;
2. Yazoo Headwater Project – authorized by the Flood Control Act of 15 May 1928 and subsequent amendments; provided protection against headwater floods of streams in the Basin; and
3. Big Sunflower River Basin Project – authorized by the Flood Control Act of 1944; provided for channel improvement for flood control in the alluvial valley of the Mississippi River.

The primary purpose of the Big Sunflower River Maintenance Project was to alleviate flooding in the basin area through channel improvements on the Big Sunflower, Little Sunflower, Hushpuckena, and their tributaries, and on Hull Brake-Mill Creek Canal, Bogue Phalia, Ditchlow Bayou, Deer Creek, and Steele Bayou, Main Canal, and Black Bayou, and water control structures in nine lakes for fish and wildlife purposes (USACE, 1975).

The Big Sunflower River Maintenance Project encompasses approximately 2,100 square miles of alluvial plain (delta). The area is drained by Steele Bayou, Deer Creek, Bogue Phalia, and the Quiver and Big and Little Sunflower Rivers and their tributaries (USACE, 1975). The original plan provided for modification of 592 miles of channel on these rivers and streams. All of the original modifications have been completed, as has some additional work on Steele Bayou (and tributaries), and Gin and Muddy Bayous.

4.1 Proposed Operation and Maintenance

The Big Sunflower River Maintenance Project consists of sediment removal and vegetation control on all or parts of the Big Sunflower River, Little Sunflower River, Bogue Phalia, Bogue Phalia Cutoff, Holly Bluff Cutoff, and Dowling Bayou south of Highway 82 to their confluence with the Yazoo River. Current stages within the areas of proposed maintenance work are one to three feet above the 1962 design flow line due to vegetation growth and sedimentation (USACE, 2001a). The proposed maintenance work would restore channel capacities to the 1962 post project flow line, reducing headwater flooding. The proposed maintenance work will not reduce the frequency or duration of backwater floods (USACE, 1996).

Maintenance Work

The channel maintenance work involves the use of a combination of dredging and dragline to excavate 8.42 million cubic yards of material. A dredge will be used to excavate 7.75 million cubic yards, and a dragline will be used to excavate 0.67 million cubic yards. Disposal areas will be utilized for placement of material from dredging. In general, the dragline will be used where rights-of-ways (ROW) currently exists, where channels are too shallow to float a dredge/barge, or, where numerous, low clearance, bridges make it uneconomical to operate a dredge. A summary of the 10 items that comprise the Big Sunflower River Maintenance Project is presented in Table 1.

Table 1.
Summary of the Big Sunflower River Maintenance Project

Item	Stream	River Miles	Method	Estimated Excavation (MCY)	Clearing & Snagging Miles
1	Big Sunflower	6.9 – 19.2	Dredge	0.58	
		19.2 – 33.5 *[1]	Dredge	0.99	
		26.1 – 28.4 *[2]	Dredge	0.17	
2	Little Sunflower	7.0 – 20.5	Dredge	1.04	
3	Little Sunflower	20.5 – 27.7	Dragline		7.2*[3]
4	Holly Bluff Cutoff	19.2 – 26.1	Dragline	0.07	
	Dowling Bayou	3.7 – 8.0	Dragline		4.3
5	Big Sunflower	28.4 – 50.2 *[4]	Dredge	1.62	
6	Big Sunflower	50.2 – 70.6 *[5]	Dredge	2.91	
7	Bogue Phalia	1.0 – 7.1	Dragline	0.34	
8	Bogue Phalia	7.1 – 19.8	Dragline	0.26	
9	Bogue Phalia	19.8 – 24.2	Dragline		4.4
	Bogue Phalia Cutoff	0.0 – 12.4	Dragline		12.4
10	Big Sunflower River	70.6 – 75.6	Dredge	0.44	
	SUBTOTAL		**Dredge**	**7.75**	
			Dragline	**0.67**	
	TOTAL			**8.42**	**28.3**

Legend: *[1] – This reach includes Big Sunflower Bendway portion of the Big Sunflower River.
*[2] – Includes 0.2 miles of no-work reach due to high concentration of mussels.
*[3] - Item 3 was completed in August 2000.
*[4] – Includes 10.1 miles of no work reaches; sufficient channel capacity.
*[5] – Includes 0.2 miles of no-work reach due to high concentration of mussels.
MCY – million cubic yards

Source: USACE 2001a.

4.2 Impacts of the Proposed Project

The potential impacts of the proposed maintenance project include land use conversion (direct) impacts and hydrologic impacts. The following paragraphs quantify the expected conversion and hydrologic impacts.

Land Use Conversion Impacts

Land use conversion Impacts are comprised of rights-of-way (ROW) clearing and associated spoil disposal. Table 2 gives the acres of cleared agricultural land and forested land (bottomland hardwoods) anticipated to be adversely impacted for the three action alternatives under consideration (USACE, 1996).

Table 2.
Land Use Conversion Impacts Associated with the Proposed Maintenance Work

Alternative	**Cleared** (acres)	**Forested** (acres)	**Total** (acres)
Hydraulic Dredge	1231	160	1391
Dragline	980	1062	2042
Preferred Alternative	1017	443	1460

Hydrologic Impacts

The proposed maintenance work will reduce the average daily acres flooded within the 2-year floodplain of the maintenance area. In the DNF area above Holly Bluff, the hydrologic impact of the proposed maintenance work would be a 2-3 day reduction in headwater flood duration; backwater flooding frequency is expected to be the same as pre-maintenance conditions. The hydrologic impacts resulting from the proposed maintenance work are the same for each action alternative that was considered.

According to the USACE (1996), the average daily acres of flooded forested wetlands (bottomland hardwoods) within the 2-year floodplain of the project area will be reduced by 1,989 acres with implementation of the maintenance project. Most important to the pondberry colonies, annual and other “frequent” flooding of areas governed by local hydrology will occur with the same pre-project frequency (USACE, 1996).

4.3 1996 Pondberry Surveys and Direct Impacts

Field surveys were conducted by the USACE in 1996 to locate any unknown colonies and to determine potential impacts that may be caused by the Big Sunflower River Maintenance Project. The following paragraphs are a summary of the 1996 surveys as presented by the USACE (1996).

Surveys were performed of the directly impacted ROW areas along the affected waterways as well as several off channel tracts that may be indirectly impacted. According to the USACE (1996), field surveys consisted of 100 percent coverage of suitable habitats within a 400-foot corridor on both banks of the affected project area. In addition, 200-foot ROW areas (foot print areas) and 200-foot buffer zones adjacent to the potential ROW areas were 100 percent surveyed for pondberry.

Two pondberry colonies were located during the ROW surveys during the 1996 surveys (USACE, 1996). One colony, which was previously located by DNF personnel, was located on the left descending bank of the Holly Bluff Cutoff in the southwest corner of Dowling Greentree Reservoir. This colony was not located in the project corridor, but was adjacent to the area surveys. The second colony was located on the right descending bank of the Big Sunflower River near Fifteen Mile Island. It was located in the ROW corridor on a high ridge of the river's natural bank at an elevation of 93.110 feet National Geodetic Vertical Datum (NGVD).

The 1996 surveys also included a one percent survey of off-channel forested tracts located north of the DNF which contained suitable habitat for pondberry (USACE, 1996). No pondberry plants were located in the off-channel surveys of potential pondberry habitat.

The 1996 BA (USACE, 1996) concluded that no direct adverse impacts would occur to pondberry colonies upon implementation of the proposed maintenance project provided the following stipulations were observed:

1. Bank clearing work on Holly Bluff Cutoff for dragline access must be conducted on the right descending bank, (as planned) especially near the northern end of Holly Bluff Cutoff. This will avoid any direct impacts to a pondberry colony located in Dowling Greentree Reservoir.
2. The spoil disposal area on the right descending bank of the Big Sunflower River adjacent to a forested bend near Fifteen Mile Island should be moved to the left

descending bank and completely situated in a cleared area. This will avoid any adverse direct impacts to a pondberry colony located on the southwestern tip of the forested bend on the river's natural bank.

5.0 2000 Survey Results

In order to update information on elevation and habitat characteristics of pondberry colonies located after the 1996 surveys, the USACE performed re-evaluation surveys for pondberry in 2000. The complete final revised survey report for the re-evaluation of pondberry in Mississippi is included in Appendix B. The USACE (2000) pondberry surveys were conducted on the Delta National Forest (DNF) in Sharkey County, Mississippi, several parcels of private land located in Bolivar County, and a 32-acre plot located south of the DNF. Additional locations that have been discovered since the Vicksburg District performed previous pondberry surveys in the early 1990's were surveyed to characterize the new pondberry colonies. The purpose of this study was to re-evaluate and update the existing pondberry profile (USACE, 1991) relative to data gleaned from recently discovered colonies. During these surveys, 62 colonies were observed. A summary of the 2000 re-evaluation surveys (USACE, 2000) findings is presented in the following paragraphs.

The elevations of the 62 colonies sampled ranged from 88 ft to 155 ft NGVD. The elevations of the 50 colonies surveyed on the DNF ranged from 88 to 99 ft NGVD. Based upon the surveyed elevations at each site and the slope-adjusted surface water elevations for various flood frequencies, these colonies occurred, on average, within the 6-year floodplain. The majority (56%) of the colonies in the DNF were found within the 2-5 year floodplain. The other colonies were distributed fairly evenly throughout the floodplains with 8% in the 0-2 year floodplain, 18% in the 5-10 year floodplain, 4% in the 10-15 year floodplain, and 14% in the 15-20 year floodplain. The correlation between pondberry density and flood frequency indicated that there is not a strong relationship between pondberry density and flood frequency. The elevations of the remaining 12 colonies surveyed outside of DNF ranged from 136 to 155 ft NGVD. All of these sites were located above the 100-year floodplain.

The three most common overstory species associated with the 62 pondberry colonies surveyed were sweetgum, willow oak, and Nuttall oak. The three most common understory species associated with the 62 colonies were sweetgum, Drummond's red maple, and sugarberry. The three most common shrub species associated with the pondberry sites sampled were sugarberry, roughleaf dogwood, and deciduous holly. Other shrub species found in high abundance near the colonies were common persimmon, American elm, red maple, and green ash. Poison ivy (*Toxicodendron radicans*) was found at all but two sites. The other most common vine species found near the pondberry colonies was *Smilax* sp., peppervine *(Ampelopsis arborea)*, and muscadine grape *(Vitis rotundifolia)*. Virginia creeper *(Parthenocissus quinquefolia)*, trumpet creeper *(Campsis radicans)*, supplejack *(Berchemia scandens)*, *Rubus* sp., false-nettle *(Boehermia cylindrical)*, and redvine *(Brunnichia cirrhosa)* were also commonly found near the pondberry colonies.

The approximate percent canopy cover of the 62 colonies sampled ranged from 40% to 99% with an average of 87%. The percent canopy cover of the 50 colonies surveyed on the DNF ranged from 70% to 99% with an average of 90%. The percent canopy cover of the 12 remaining colonies ranged from 40% to 95% with an average of 77%. The correlation between pondberry density and percent canopy cover indicated that there is not a strong relationship between percent canopy cover and pondberry density.

The approximate diameter at breast height (DBH) of the overstory tree species near the 62 pondberry colonies ranged from 9.3 inches (in) to 45.8 in with an average of 20.4 in. The correlation between elevation and DBH indicated that there is a slightly negative relationship, but that there is not a strong relationship between DBH and pondberry density.

The approximate percent herbaceous cover around the pondberry colonies ranged from 1% to 98% with an average of 63%. Of 50 pondberry colonies surveyed, the average colony size was 1988 ft^2 (0.045 acres), as measured by Professional Land Surveyors.

The 2000 re-evaluation found that common associate species were similar to previous studies of the Mississippi pondberry populations. Common associate tree species were sweetgum, oaks, and elms while associate shrub species were sugarberry, swamp dogwood, and deciduous holly. However, it should be noted that the DNF is managed for oaks, so the importance of oaks as associate species may be over-estimated. The field team noted that spicebush was absent in areas where pondberry was present. The reverse was also true at Dahomey National Wildlife Refuge, where extensive colonies of spicebush, but not pondberry, were found.

Previous studies suggested that pondberry colonies in Mississippi are shade tolerant and probably shade dependent (USACE, 1991a, 1991b). A recent study by Devall *et al*. (2000) reported that the most vigorous colonies they observed were in locations with abundant light.

However, these colonies were found in Georgia, in an entirely different habitat type. Devall *et al.* (2000) also reported that colonies in Mississippi were also found in areas of high canopy cover. Of the colonies surveyed in 2000, approximately 90 percent of the colonies were found in areas with a high percent canopy cover. In addition, colonies located in areas of low percent canopy cover generally had a high abundance of competition from vines. The 2000 surveys suggest that pondberry colonies located in the DNF are indeed shade tolerant, and possibly shade dependent, as indicated by previous studies in this area (USACE, 1991a, 1991b).

Based on physical and biological data, there was no correlation between health of the colony, measured by stem density, stem diameter, or stem height, and elevation. There was also no correlation between health of the colony, measured by stem density, and percent canopy cover or DBH. Therefore, it is difficult to predict where pondberry might be successful by using these quantifiable variables. Instead, evidence from this and previous studies suggest that, in general, pondberry is successful in areas of high percent canopy cover, in a ridge and swale community, and in areas that are mostly affected by local precipitation and hydrology.

For an independent review of the 2000 data, conducted by Dr. Dale Magoun, see Section 6.0 or the entire document can be found in Appendix C.

5.1 Data Analysis

Existing conditions data from known pondberry colonies in Mississippi are included as an appendix to the Revised Survey Report Re-evaluation of Pondberry in Mississippi (Appendix B). Subsequent analysis of the 2000 survey data showed that, on the average, the 50 colonies are subject to overbank flooding once every six years. Floodplain data for 61 of the 62 pondberry colonies surveyed during the 2000 surveys is presented in Table 3.

Table 3
Existing Flood Frequency Data for Pondberry Sites

Floodplain	Delta National Forest		Locations Outside Delta National Forest	
	Number of Colonies	Percent	Number of Colonies	Percent
0-2 year	4	8	0	0
2-5 year	27	56	0	0
5-10 year	9	18	0	0
10-15 year	2	4	0	0
15-20 year	7	14	0	0
20-100 year	0	0	0	0
>100 year	0	0	12	100
Average	**6-year floodplain**		**> 100-year floodplain**	

The existing flood frequency for known pondberry locations was then used by the USACE to estimate the flood frequency with the proposed Big Sunflower River Maintenance Project. Floodplain data for the pondberry colonies with the proposed project are presented in Table 4.

Table 4
Flood Frequency Data for Pondberry Sites With The Big Sunflower River Maintenance Project

Floodplain	Delta National Forest		Locations Outside Delta National Forest	
	Number of Colonies	Percent	Number of Colonies	Percent
0-2 year	2	4	0	0
2-5 year	17	35	0	0
5-10 year	20	41	0	0
10-15 year	2	4	0	0
15-20 year	8	16	0	0
20-100 year	0	0	0	0
>100 year	0	0	12	100
Average	**7-year floodplain**		**> 100-year floodplain**	

The results of this analysis show that with the proposed project, two colonies would move from the 0-2 year floodplain to the 2-5 year floodplain; 12 colonies would move from the 2-5 year floodplain to the 5-10 year floodplain; one colony would move from the 5-10 year floodplain to the 10-15 year floodplain; and one colony would move from the 10-15 year floodplain to the 15-20 year floodplain. Of those colonies in DNF, the flood frequency decreased an average of 1.2 years. Based upon the surveyed elevations at each site and the slope-adjusted surface water elevations for various flood frequencies, these colonies would occur with project implementation, on average, within the 7-year floodplain.

One colony is located inside the Sunflower Greentree Reservoir where flooding is controlled by the U.S. Forest Service. The current flooding regime will not be altered and this colony would not be affected by the proposed project. The 12 colonies outside of DNF would remain above the 100-year floodplain and the current flooding regime will not be altered. These colonies would not be affected by the proposed project.

Past field investigations (USACE, 1991a) determined that the majority of the extant pondberry on the DNF are located at an average elevation of 95 feet NGVD based on USGS topographic map locations. Analysis of the 2000 survey data supports this conclusion with the majority of the 62 colonies surveyed (81 percent) were located at an average elevation of 95.009 feet NGVD. According to these data, the colony at the lowest elevation is inundated by overbank flooding every 0.7 years and the colony at the highest elevation is subject to overbank flooding every 17 years.

The average distance of a colony from a standing body of water (as measured by Professional Land Surveyors) was 64.0 feet. Of the 50 colonies located on DNF, the average distance of the pondberry colonies from a water body was 80.0 feet. Only the colonies found outside of DNF were found in areas inundated with water, or areas of recent inundation. None of the colonies found within DNF were found in standing water. However, of 61 colonies surveyed, 93 percent (57 colonies) were found in areas with evidence of localized depression flooding as measured by Professional Land Surveyors (USACE, 2001b).

5.2 Subsequent Studies

5.2.1 USFWS Hydrology and Habitat Evaluation

The most recent study of pondberry colonies in Mississippi was conducted by the USFWS as part of the evaluation of the effects of the Yazoo Backwater Reformulation Report. The USFWS (2001) performed a hydrology and habitat evaluation of 51 colonies of pondberry in DNF. During this evaluation, ponded water from rainfall was present during May 2001 at two pondberry colonies which were used as an ecological benchmark to compare to other colonies on DNF. This evaluation found that five sites (10 percent) of the colonies were clearly related to ponded depressions, 11 sites (20 percent) probably have shallow standing water due to rainfall at irregular intervals, and 35 sites (70 percent) were not depressional wetland colonies. This study does indicate that pondberry is not associated with typical wetland communities.

5.2.2 Independent Review of Pondberry Data, Dr. Dale Magoun 2001

An independent statistical review of pondberry data for the Big Sunflower River Maintenance Project was conducted by Dr. Dale Magoun (2001). Appendix D contains the statistical analysis performed by Dr. Magoun for the Big Sunflower River Maintenance Project. Dr. Magoun's analysis of the pondberry data showed that frequency of flooding as measured, did not adversely affect pondberry characteristics. Pondberry characteristics included number of clumps, number of stems, number of dead stems, number of females or mature fruit, stem height, and stem diameter as measured. Dr. Magoun found that the statistical non-significant test was associated with a relatively high power; therefore, there will be no flooding effects on pondberry from the Big Sunflower River Maintenance Project and the project is not likely to affect pondberry.

6.0 Yazoo Backwater Reformulation Report and Biological Assessment

The Yazoo Backwater Reformulation Report, as authorized, includes flood control measures including levees, associated drainage channels, pumping plants, and floodgates designed to reduce flooding in the Yazoo Backwater Area which includes the Big Sunflower River Basin. As part of the Reformulation Report the USACE prepared a Biological Assessment on the effects of the proposed project on pondberry. Appendix 14 of the Yazoo Backwater Reformulation Report contains the BA of the effects of the Yazoo Backwater Reformulation on extant pondberry colonies.

In this BA, the USACE concluded that there is no relationship between variation in the density of pondberry and variation in flood frequency. The USACE found that the abundance of pondberry within a colony is a random feature in the bottomland hardwood flood environment, where pondberry is as abundant at sites that flood once every two years as at sites that flood only once every 100 years. In the Review of Appendix 14: Pondberry Biological Assessment from the Yazoo Backwater Reformulation Report dated October 16, 2000, The USFWS disagreed with these findings, stating that the analysis of correlation between the densities of pondberry to frequency of flooding is insufficient to discount any effect of flooding. In addition, their response included questions to the USACE regarding the Big Sunflower River Maintenance Project. The USFWS stated that new information was presented in the 1996 BA concerning the elevation and floodplain of pondberry colonies on Delta National Forest. This information was not available during the previous review of the Big Sunflower River Maintenance Project by the USFWS. In their review of the Yazoo Backwater BA, the USFWS asked several questions concerning the previous BA (1996) on the effects of the Big Sunflower River Maintenance Project. On May 6, 1994 the USFWS concurred with the USACE assessment that the Big Sunflower River Maintenance Project would not likely adversely affect pondberry. The USFWS stated that whether or not they would recommend that formal consultation should now be initiated of the effects of the Big Sunflower River Maintenance Project to pondberry would depend in part on the USACE response to these questions. Summaries of the questions posed by the USFWS as well as the responses of the USACE (2001c) are given in the following paragraphs.

1. Question: To what extent will the Big Sunflower River Maintenance Project reduce flood frequency, in addition to duration, to the pondberry colonies reported by the Pump

Project? Will these colonies experience a 2-3 day reduction in headwater flood duration or will effects differ?

Response: The base conditions flood frequency for the 50 pondberry colonies in the Delta National Forest upon which hydrologic data has been collected is the 6-year flood frequency. With the Big Sunflower River Maintenance Project in place the flood frequency for these pondberry colonies will be a 7-year flood frequency. The observed pondberry colonies will experience a 2-3 day reduction in headwater flood duration as a result of the Big Sunflower River Maintenance Project; however, the project will not impact the local hydrology which has been shown to have a preeminence of importance to the livelihood of the pondberry beyond the effect of major river overflow or backwater ponding.

2. Question: What methods were used to predict a 2-3 day reduction in headwater flooding? Are these methods the same as used in the BA for Pump Project? If not, how do predictions of a reduction in flood frequency, timing, and duration vary by these different methods?

   Response: A hydrologic analysis using a typical headwater flood hydrograph was used to determine the 2-3 day reduction in headwater flood duration for the pondberry colonies with the Big Sunflower River Maintenance Project in place. A detailed hydrologic analysis of each pondberry colony was made to evaluate the impact of flood frequency changes as a result of the Big Sunflower River Maintenance Project and the Yazoo Backwater Area Reformulation. In addition a detailed analysis of the localized hydrology impacts was also made for each pondberry colony. The same methodology of determining the impacts to the flood frequency for each individual pondberry colony was used in the Yazoo Backwater Reformulation and the Big Sunflower River Maintenance Project.

3. Question: For the areas located at or below the 2-year floodplain, regardless if pondberry is known to occur in such areas, will the project reduce flood frequency and duration?

   Response: Yes. The Big Sunflower River Maintenance Project will reduce the flood frequency and headwater duration; however, of the 50 pondberry colonies only 4 of the pondberry colonies are located below the 2-year floodplain. In addition, the project will not impact the local hydrology, which has been shown to have a preeminence of importance to the livelihood of the pondberry beyond the effect of major river overflow or backwater ponding.

4. Question: The USACE reported that the 2-year floodplain habitat of the Big Sunflower River Maintenance Project area would be reduced by 1989 acres (bottomland hardwoods). Is this the area of a 2-3 day reduction in headwater flooding, and if not, what is the nature of this reduction? Is pondberry known to occur in this area, and if not, what surveys were conducted?

   Response: This is an area that could experience a 2-3 day reduction in headwater flood duration. Of the 50 observed pondberry colonies, only four of the observed pondberry colonies are located below the 2-year floodplain.

5. Question: Would the USACE conclude, as in the Pumps (Yazoo Backwater Reformulation) BA, that any pondberry colony regardless of the current flood frequency, timing, and duration would not be adversely affected by a reduction in flood hydrology because of the hydrologic predominance of local ponding of rainfall to the ecology of this species?

   Response: Yes. The Corps concurs that the reduction in flood frequency and the 2-3 day headwater duration reduction as a result of this project will not impact the local hydrology, which has been shown to have a preeminence of importance to the livelihood of the pondberry beyond the effect of major river overflow or backwater ponding.

In addition, an independent review of the Yazoo Backwater Area Biological Assessment was conducted by Dr. Dale Magoun (Appendix C). Dr. Magoun's analysis of the 2000 data showed that frequency of flooding as measured, did not adversely affect the characteristics of the number of clumps, number of stems, number of dead stems, number of females or mature fruit, stem height, and stem diameter as measured in this study. In addition, he found that there appears to be no meaningful correlation between distance from water and the pondberry bush characteristics as measured. Dr. Magoun found that changes in elevation, ground cover, and overstory species appear to effect different characteristics of pondberry, but not the occurrence of pondberry. Dr. Magoun found that in his analysis of the 2000 survey data, pondberry:

- colonies tend to be associated with areas with less canopy cover and overstory species with a smaller DBH
- colonies with more fruit are also associated with areas with less canopy cover and overstory species with a smaller DBH
- colonies with larger stem diameters tend to be associated with areas with more canopy cover and overstory species with a larger DBH
- colonies with larger stem heights tend to be associated with areas that are lower in elevation
- colonies that are characterized by more clumping and more stems tend to be associated with areas that are higher in elevation

7.0 Conclusions

The results of the 2000 survey are similar to the results of the pondberry profile conducted by the USACE in 1991 and those presented in the 1996 BA. They determined that a typical pondberry colony found within the Mississippi Delta should occur on slight ridges in a ridge and swale community which is periodically flooded. Results from this current study indicated that the average elevations of pondberry colonies were within the 6-year floodplain. These results are similar to those conducted by the USACE in 1996. Although this study determined that the pondberry colonies found within the DNF occurred within the 6-year floodplain on average, the majority of the colonies were located within the 2-5 year floodplain. Of 61 colonies surveyed, 93 percent (57 colonies) were found in areas with evidence of localized depression flooding as measured with surveying equipment (USACE, 2001b).

As stated in the 1996 BA, no direct impacts to pondberry colonies will occur provided the stipulations outlined in the 1996 BA are followed (See Section 4.3). Subsequent surveys, evaluations, and this BA support this conclusion.

The results of this study concur with previous reports that pondberry is more likely to be influenced by local precipitation and hydrology, rather than by overbank flooding. It must be noted that pondberry colonies located within a 6-year floodplain will not necessarily be flooded every six years. The presence of barriers, such as levees, roads, structures, or natural ridges will also affect the flooding near colonies even when a 5-year storm event occurs.

In conclusion, it is unlikely that pondberry would be adversely affected by changes in the flood regime in the Big Sunflower River Basin. The 1991 profile, the 1996 Biological Assessment, and this study indicate that the pondberry colonies in the DNF are influenced more by local hydrology, rather than overbank flooding. The proposed flood control would not affect local hydrology and thus would not directly or indirectly affect the pondberry colonies. Since the colonies within the Big Sunflower River Maintenance project area are located on Federal lands (i.e., DNF), reductions in flood frequencies would not induce additional clearing of bottomland hardwood communities that could potentially impact pondberry populations.

However, due to the sparse knowledge of the biology of pondberry, the USACE has committed to monitoring extant colonies and to conduct experimental research in order to fully understand pondberry's relationship to altered hydroperiods (See Section 8.0).

8.0 Monitoring and Research

Due to the limited understanding of the biology of pondberry, the USACE, in partnership with the U.S. Forest Service and USFWS, has committed to conduct extensive research on the requirements of pondberry. Over the next several years, the USACE proposes to conduct experiments on pondberry in the following areas: the role of flooding and sunlight, impact of periodic flooding on competition, dynamics of native pondberry colonies, role of stem dieback, population genetics, and seed ecology.

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10.0 Appendices

Appendix A. 1996 Biological Assessment (includes1991 Pondberry Profile)

Appendix B. Revised Final Report: Survey Report Re-evaluation of Pondberry in Mississippi

Appendix C. Review of Appendix 14: Pondberry Biological Assessment, A. Dale Magoun, Ph.D.

Appendix D. Independent Review of Pondberry Data, Dr. Dale Magoun 2001

Appendix A
1996 Biological Assessment
(includes 1991 Pondberry Profile)

Appendix B
Revised Final Report: Survey Report
Re-evaluation of Pondberry in Mississippi

FINAL
BIOLOGICAL ASSESSMENT OF IMPACTS TO PONDBERRY (*Lindera melissifolia*) RESULTING FROM THE BIG SUNFLOWER RIVER MAINTENANCE PROJECT

Prepared for:
U.S. Army Corps of Engineers
Vicksburg District

By:
Geo-Marine, Inc.

Baton Rouge, Louisiana

July 1996

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Biological Assessment
of Impacts to Pondberry (*Lindera melissifolia*)
Resulting from the Big Sunflower River Maintenance Project

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I. INTRODUCTION

This Biological Assessment (BA) addresses the potential impacts to the endangered plant, pondberry (*Lindera melissifolia*), that may occur upon implementation of maintenance dredging alternatives within the Big Sunflower River basin, Mississippi.

This study was conducted by Geo-Marine, Inc. (GMI) for the Vicksburg District, U.S. Army Corps of Engineers (USCOE), under Contract No. DACW38-92-D-0018, Delivery Order No. 0004. This document presents a review of pertinent literature revealing the ecology, life history, and other biological characteristics of pondberry; the results of the field survey within the project area; and finally, assesses the effects of the proposed Big Sunflower River maintenance project on pondberry populations within Mississippi. The BA was prepared in accordance with guidelines specified under Section 7 of the Endangered Species Act of 1973, as amended.

A. Report Organization

The BA is divided into five major sections, including this introduction. Section 2 discusses pondberry's life history, ecology, and current status based upon extensive review of published and unpublished data. Section 3 presents a brief summary of the Big Sunflower River project. Section 4 presents the methods and results of field surveys conducted within the Big Sunflower River project area as well as surveys conducted in the Upper Steele Bayou basin and the Upper Yazoo projects area. Potential impacts of the proposed maintenance project on pondberry are described in Section 5. Appendix A contains a copy of a pondberry profile report prepared by the USCOE for the Upper Yazoo and Steele Bayou Projects in 1991. Appendix B presents minutes and handouts from interagency meetings on the potential impacts of pondberry due to implementation of the proposed maintenance project.

II. LITERATURE REVIEW

A. General

Lindera melissifolia, commonly known as pondberry, Jove's fruit, or southern spicebush, was first described in 1788 by Walter as *Laurus melissaefolia* in Flora Caroliniana from specimens he collected within a 50 mile (31 km) radius of his home. This site is located in present-day Berkley County, South Carolina at the southern edge of the Great Swamp bordering the Santee River. (Klomps 1980a and 1980b).

Early authors easily distinguished *L. melissifolia* from the more common *L. benzoin* (spicebush). Their descriptions stressed the overall low profile of the plant, shape of the leaves, prominent venation, and pubescence of the lower leaf surface. However, confusion with *L. benzoin* began in 1864 with DeCandolle's Prodromus 15, part 1:244, in which DeCandolle mentioned a reference by Meissner to a collection of *L. melissifolia* collected by Englemann from Missouri. J. A. Steyermark examined the specimen and found that it was actually a pubescent form of *L. benzoin* which was later described by Steyermark and Palmer (1935) as *Benzoin aestivale* var. *pubescens* (*Lindera benzoin* var. *pubescens*). The discovery of Meissner's mistaken identification led to the discovery that the pubescent form of *L.*

benzoin had frequently and mistakenly been included in *L. melissifolia*. This resulted in an inaccurately large range for the species that included parts of Illinois and Missouri.

In Missouri, *L. melissifolia* was not discovered until 1948 when Steyermark found it in Ripley County. Steyermark referred to pondberry as potentially being "... one of the rarest shrubs in the United States..." based on the extremely low numbers of herbarium specimens in the United States. He described the species in 1949 and his description is one of the most detailed accounts of the morphology and taxonomy of pondberry.

Since Steyermark's description, various documents discussing the morphological characteristics, apparent or expected habitat requirements, distribution, status, and similar factors have been prepared. The following sections of this report incorporate various references to pondberry that are pertinent to this investigation.

B. Species Description

1. Nontechnical Description

Lindera melissifolia is a low growing, deciduous shrub ranging in height from 0.5 to 2 meters (1.5 to 6.5 feet). The plants reproduce vegetatively by means of stolons and typically grow in clones of numerous, unbranched, scattered stems that somewhat resemble a "plum thicket." The older portions of the stems are dark green to almost black with numerous irregularly spaced but prominent lenticels, which appear very similar to saplings or young stems of sassafras (*Sassafras albidum*). The leaves are drooping, 1.9 to 6.35 cm (0.75 to 2.5 inches) wide and 5.1 to 16.51 cm (2 to 6.5 inches) long with a round to cordate base and have a distinct sassafras-like odor when crushed. Leaf veins are prominent and the undersurface of the leaf is hairy. The male and female flowers are found on separate plants. Flowers of both sexes are pale yellow and small and appear in spring prior to leaf development. The flower stalks and buds are often hairy. The fruits mature in the fall (October) and are about 12 mm (0.5 inches) long, oval-shaped, and bright scarlet red. Fruit stalks are often present until the following year's flowering (USFWS 1992; Klomps 1980a; and Tucker 1984).

2. Technical Description

The following technical description was taken directly from Steyermark's (1949) description of the species:

> "Low shrub, 0.6-2 meters tall; foliage drooping, when crushed with a sassafras-like odor; leaf blade thin, membranaceous, oblong, obtuse or rounded at base, 5-16 cm long, 2-6 cm wide, concolorous, slightly to densely pubescent on lower surface; lower surface of blade with conspicuous pronounced venation; lowest two pairs of lateral nerves not parallel to ones above, conspicuously more ascending and diverging from midrib at 45-50 degree angle, in contrast to the other lateral nerves which diverge at an angle of approximately 35 degrees; petiole and buds pubescent, 5-15 mm long; fruiting pedicels stout, 9-12 mm long, conspicuously enlarged at summit, 2.5-3 mm wide; mature fruit (in dried state) elliptic-obovoid, 10-11.5 mm long, 7-8 mm wide, seed suborbicular, 7 mm long, 6.25 mm wide; winter buds villous; staminate calyx-segments 1-1.25 mm wide; staminate pedicels pilosulous; filaments slender, narrower, 0.1 mm wide, not dilated at base, 1.8-1.9 mm long; pistillate calyx-segments 1.5-2mm

long, 1-1.25 mm wide; pistillate pedicels 2.5 mm long; fruiting pedicels persistent from previous year and lasting to time of anthesis."

C. Taxonomic Information

Pondberry (*Lindera melissifolia*) is in the laurel family, Lauraceae, and is one of three members of the genus *Lindera* found in North America. This genus also includes *Lindera benzoin* and *Lindera subcoriacea*, a new species described by B.E. Wofford (1983). Pondberry can be distinguished from the other two members of the genus by its drooping, thin, membraneous, and ovately to elliptically shaped leaves that exude a sassafras-like odor when crushed. Five other genera of the family Lauraceae are found in southeastern U.S. forests: *Persea, Ocotea, Sassafras, Misanteca*, and *Litsea* (Radford et al. 1968; and Harrar and Harrar 1962).

Several synonyms exist for pondberry including: *Laurus melissaefolia*, Walter, in Flora Caroliniana, 1788; *Benzoin melissaefolium*, (Walt.) Nees, in Systema Laurinarum, 1836; *Laurus diospyroides*, Michx. in Flora boreali-americana, 1803; *Laurus diospyros*, Pursh. in Flora americae septentrionalis, 1814; and *Eyosmus diospyrus*, Nutt. in The Genera of North American Plants, 1818.

D. Status and Geographic Range

Pondberry is currently listed as a Federally endangered species under the Endangered Species Act of 1973. Pondberry was officially listed as endangered on July 31, 1986, in the Federal Register (51:27495-27499). A final recovery plan was recently completed by the U.S. Fish and Wildlife Service (USFWS) in September 1993.

At least 38 populations are currently known to exist, ten populations in Arkansas, five populations in Georgia, fourteen populations in Mississippi, one population in Missouri, three populations in North Carolina, and five populations in South Carolina (USFWS 1993). A population has been defined as "one or more colonies that are in close enough proximity to regularly interbreed and separated from other populations by a sufficient distance to preclude interbreeding on a regular basis" (USFWS 1993). However, the distance to preclude interbreeding has not been defined. Historically, pondberry has also been reported from Alabama, Florida and Louisiana but it is considered to be extirpated from these locations (USFWS 1993; and Tucker 1984). The current status of pondberry within these states is discussed in the following paragraphs.

Alabama. Pondberry has not been observed or collected in Alabama since 1839 and 1840 when it was collected from Wilcox County (Tucker 1984).

Florida. The occurrence of pondberry from Gadsden or Jackson Counties in Florida has been confirmed from herbarium records dated mid-1800's.

Louisiana. A single collection of pondberry is recorded from Hale, Louisiana from an unknown location. There have been no recent observations or collections of pondberry within the state.

Arkansas. Ten populations of pondberry are known to exist in Arkansas, in Clay, Woodruff, Lawrence, and Jackson counties. These populations are all located on privately owned land.

Georgia. Five populations are known to exist in Georgia within Wheeler and Baker counties. Four of the populations are on privately owned land while one is located in Little Ocmulgee State Park.

Mississippi. According to the USFWS (1993), 13 populations are known to exist in Mississippi; however the USCOE recently discovered another population in Tallahatchie County, Mississippi bringing the total number of populations to 14. The majority of the populations (10) are located in the Delta National Forest (DNF). The other four populations are located on private land — two in Sunflower County, one in Bolivar County, and one in Tallahatchie County.

Missouri. One population is known to exist in Ripley County. This population is located on land that is owned both privately and by the Missouri Department of Conservation and The Nature Conservancy. An experimental population has also been established in Butler County on property owned by the Missouri Department of Conservation.

North Carolina. Three populations are known to occur in North Carolina in Bladen and Sampson counties. All populations are located on privately owned land.

South Carolina. Five populations of pondberry are known to exist in South Carolina with four populations occurring in the Francis Marion National Forest and one population on a Marine Corps Air Station in Beaufort County.

E. Regional Habitat

1. General

The habitat requirements of pondberry appear to be highly variable across its range. In the Mississippi alluvial plains of Arkansas, Missouri, and Mississippi, pondberry occurs on sites with perched water tables and vegetation similar to that of bottomland hardwood habitats. In coastal areas of North Carolina and South Carolina, pondberry is associated with the margins of ponds, sinks, and depressions in pinelands (USFWS 1992). In general, pondberry occupies wetland habitats that are normally flooded or saturated during the dormant season but infrequently flooded during the growing season for extended periods (Tucker 1984). The specific habitat types occupied by pondberry have been variously described, e.g., "inhabits mesic to hydric sites (i.e., bottomland hardwoods, depressions, and margins of sandy sinks and ponds)" (Wofford 1983) and "sandy sinks and pond margins, swamps and pond margins, and swampy depressions" (Porcher 1980).

The following sections discuss the apparent habitat requirements of pondberry by region. These habitat types vary from the edges of limestone sinks in South Carolina to ridge and swale communities within bottomland hardwoods in Mississippi. Although factors such as associate species and soils are variable across its range, the characteristic of occupying edges of locally depressed or ponded areas is consistent throughout its range.

2. Missouri/Arkansas

The Arkansas and Missouri populations are considered, historically, to have been a single contiguous population. However, habitat destruction and alteration have resulted in two disjunct units (Tucker 1984; and USFWS 1993). Due to the similarity of their habitats and historical relation, the two colonies are discussed together.

a. Habitat

The pondberry populations in Arkansas and Missouri are found in depressions associated with forested swales in dune fields. These dune fields were formed by glacial outwash during the late Wisconsin glaciation (Saucier 1978) and are hydrologically connected by movement of ground water Wright (in litt.). The dunes range from two to 10 feet higher than the depressions and form natural swamps and ponds that hold water up to 20 inches during the spring, but are typically dry by October. Pondberry grows on the level ground or on the side slopes of the depressions but does not grow on the higher adjacent dunes.

b. Soils

The soils in these dune fields are typically loams and silty loams with high calcium ion exchange capabilities in the subsurface zone. The interdune areas are primarily composed of exposed sediments of predune soils rather than outside soils washed in to the area. The soils at the pondberry sites are composed of the Boskett-Tuckerman Series (Allgood and Persinger 1978) with Ordovician dolomites as the primary underlying geologic substrate. The soils are fairly acidic, poorly drained, and have high water tables.

c. Associate Species

Pondberry typically occupies the depressions or lower side slopes while spicebush, *Lindera benzoin*, is found on the higher, adjacent, nonflooding ground. Common overstory trees are pin oak (*Quercus palustris*), overcup oak (*Q. lyrata*), willow oak (*Q. phellos*), Nuttall oak (*Q. nuttallii*), swamp red maple (*Acer rubrum* var. *drummondii*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), and persimmon (*Diospyros virginiana*) (Klomps 1980b; and Tucker 1984). Common shrub, herbaceous and vine associates have been reported to include greenbrier (*Smilax glauca*), lizard's tail (*Saururus cernuus*), bedstraw (*Galium* sp.), bitter cress (*Cardamine bulbosa*), plum (*Prunus* spp.), and ironwood (*Carpinus caroliniana*) (Klomps 1980b).

3. North Carolina

a. Habitat

Pondberry habitat in North Carolina is typically shrubby. Pondberry is described as inhabiting an area associated with "...bay forest vegetation (but which has been largely destroyed through fire, resulting in a disclimax composed of more shrubs than formerly)" (Tucker 1984). Large amounts of charred wood fragments are present on the surface, indicating a heavy fire in the past.

b. Soils

The soils at the North Carolina site have high peat content in the subsurface layer and are overlain by sandy sediments. A high water table is also present in the area.

c. Associate Species

Common tree and shrub associates in pondberry areas in North Carolina are fetterbush (*Lyonia lucida*), high bush blueberry (*Vaccinium corymbosum*), red bay (*Persea borbonia*), titi (*Cyrilla racemiflora*), waxmyrtle (*Myrica* spp.), greenbrier (*Smilax* spp.), sweet bay (*Magnolia virginiana*), black gum (*Nyssa sylvatica* var. *biflora*), pond cypress (*Taxodium ascendens*), red maple (*Acer rubrum*), pond pine (*Pinus serotina*) and longleaf pine (*Pinus palustris*) (S. Morgan 1983; and Tucker 1984).

4. South Carolina

a. Habitat

The habitat of pondberry in South Carolina is notably different from that of the other sites. Pondberry occurs in two habitat types in South Carolina, at the margins of limestone sinks and shallow depressions that formed by roof collapses of underground caverns. These sinks and depressions are found both in pinelands and in open areas and some sites have been burned. The limestone sinks generally maintain water through most of the year by either artesian water or rainwater. Typically, water is present in the sinks year round and pondberry plants are found on the periphery of the limestone sinks at elevations where normal high water levels occur. The plants are generally free of competing vegetation at these high water levels. The shallow pineland depressions are fed by rainwater and often maintain water for several months. Pondberry generally grows in standing water within these depressions (Porcher 1980). Most are found in light shade but others have been observed in unshaded conditions and appear to be thriving (USFWS 1992).

b. Soils

Soils at the South Carolina sites are very acidic but are underlain by deep limestone. This combination results in very few basic ions being available at the surface. The pH at the surface has been measured at 4.5 while the pH at the subsurface layer was measured at 5.5.

c. Associate Species

The associate species within the limestone sink habitat of South Carolina was documented by Radford et al. (1973). The reported tree species within the sinks are pond cypress (*Taxodium ascendens*) and black gum (*Nyssa sylvatica* var. *biflora*). The dominant tree species around the sink's edge include loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), laurel oak (*Q. laurifolia*), live oak (*Q. virginiana*), sweetgum (*Liquidambar styraciflua*), and blackgum (*Nyssa sylvatica* var. *biflora*). Associate shrub species within the sinks include dahoon (*Ilex cassine*) and pond-spice (*Litsea aestivalis*), while additional associates on the sink's edge include wax myrtle (*Myrica cerifera*), black highbush blueberry (*Vaccinium atrococcum*), St. Andrew's cross (*Hypericum hypericoides*), St. Peter's-wort (*Hypericum stans*), inkberry (*Ilex glabra*), American holly (*Ilex opaca*), and stagger-bush (*Lyonia mariona*). A common associate noted in the pineland depressions habitat of South Carolina is the marsh fern, *Woodwardia virginia* (Porcher 1980).

5. Mississippi

a. Habitat

Tucker (1984) reported that pondberry populations in Mississippi are associated with "... mature bottomland hardwood forests in low depressions." Populations are currently known to exist in the Delta Region of west-central Mississippi. The habitat of pondberry here is similar to that in Arkansas and Missouri (USFWS 1990). The USCOE (1991a) reported that pondberry colonies in Mississippi are typically found on slight ridges in a ridge and swale community which is either frequently or periodically flooded or is in proximity to a permanent waterbody. The extant populations in Mississippi are all associated with bottomland hardwoods at elevations where rainfall/local hydrology dominates the hydrologic conditions at the pondberry colony site. Mississippi populations on the DNF are shade tolerant and found at elevations ranging from the approximate two-year to the 50-year floodplain of the lower Big Sunflower River Basin (USCOE 1994). A recently discovered colony in the Upper Yazoo basin was determined to be above the 100-year floodplain of the Yazoo River by the USCOE.

b. Soils

The Mississippi populations are most frequently found on soils characterized by the Sharkey-Alligator-Dowling Association and less frequently on soils characterized as Alligator-Dowling-Forestdale Association as delineated by Soil Conservation Service (SCS) soil survey maps of Sharkey County Mississippi. These soil associations are very similar with both being found on level, poorly drained soils in slackwater areas and depressions. The Alligator-Dowling-Forestdale Association can also be found on old natural levees (SCS 1962). The soils within these associations all have poor drainage, high water table, low permeability rates, and gleyed B and C horizons (Tucker 1984; and Banker and Goetz 1989). The tight clay subsoils of these associations results in slow permeability rates (0.2-0.6 in/hr near surface and 0.06 in/hr in subsoils). Therefore overland sheet flow dominates water movement in these soils (Banker and Goetz 1989).

The USCOE (1991a) reported that of 44 colonies sampled, 41 percent were located in surface soils classified as silty clay, 32 percent is silty clay loams, and 21 percent in silt loam soils. This indicates that pondberry colonies will not likely be found on strictly heavy Alligator, Sharkey, or Dowling clay soils. Extant pondberry colonies are found on soils with a mixture of heavy clays and lighter soils.

c. Associate Species

Common reports of associate species for the Mississippi populations lists only tree species such as oak (*Quercus* spp.), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), hickory and pecan (*Carya* sp.), etc. (Morgan, 1983; Tucker, 1984). The USCOE (1991a), through collection of field data from 44 colonies in Mississippi, was able to more clearly define associate tree and shrub species.

The most common mature or overstory tree species found at these 44 colonies, in descending order of frequency, include: oaks (*Quercus phellos, Q. nuttallii*, and *Q. lyrata*), sweetgum (*Liquidambar styraciflua*), and elms (*Ulmus crassifolia, U. americana*, and *U. alata*). The most frequent associate understory species are *Liquidambar styraciflua* and *Celtis laevigata*. Common shrub species, in descending order of frequency include snowbell (*Styrax* *americana*), deciduous holly (*Ilex decidua*), sugarberry (*Celtis laevigata*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), elms (*Ulmus* spp.), roughleaf dogwood (*Cornus drummondii*), *Quercus* spp., palmetto (*Sabal minor*), elderberry (*Sambucus canadensis*), persimmon (*Diospyros virginiana*), red mulberry (*Morus rubra*), and sweetgum (*Liquidambar styraciflua*).

F. Ecology and Life History

1. Population Biology

Pondberry populations are generally associated with the shade of a mature forest and are possibly shade dependent (Klomps 1980; Tucker 1984). Pondberry will grow in full sun but then in a stunted condition. Colonies in Mississippi occur in small dense clumps usually averaging less than 0.10 acre in size. Recent field investigations indicated that vigorous healthy colonies were found in homogeneous clumps with shrub associates growing adjacent to but not within the clumps. In less vigorous colonies, shrub/vine associates were usually growing within the clumps.

Individual stems within each colony are short-lived, generally dying by their seventh or eighth year. Young stems sprout from the rootstock and replace the dying stems. Over time, colonies may expand vegetatively resulting in many vastly rooted stems. A typical vigorous colony, thus, is composed of numerous relatively tall stems, dead and dying stems, as well as young leaf sprouts. There is little record of new seedling establishment and growth; therefore, colony expansion is suspected to be purely vegetatively (Tucker 1984; and USFWS 1990).

2. Repreductive Biology

Individual stems of pondberry begin flowering in their second to fourth year of growth (USFWS 1992). Flowering begins in late February to early March in Mississippi and generally lasts no longer than two weeks. Pondberry is dioecious (male and female flowers found on separate plants). A typical colony in Mississippi is composed primarily of male stems with few to several female stems. In some instances, the entire colony is composed of male plants. In general, seed production in relation to the total number of stems is low. Because flowering occurs in late February to early March, frost or near freezing temperatures often damage flowers, thereby reducing fruit production even more. Rayner and Ferral (1988), in a study of 73 colonies from the Honey Hill region of South Carolina, reported that only 22 percent of all colonies surveyed produced fruit, with fruit production averaging only 22 fruits per colony. They also noted that fruit production did not seem to improve with plant health since sexual reproduction appeared to be poor even in large, healthy plants.

Few details are known about pondberry's breeding system. Due to the similarity between the flowers of pondberry and *L. benzoin*, it is suspected that pondberry is insect pollinated like *L. benzoin*. Tucker (1984) noted small bees, wasps and flies on flowers when observing plants in Arkansas and Missouri. The fruit contains many oils and similar compounds, which are suspected to make the fruit distasty to most wildlife. Therefore, seed dispersal is likely accomplished by seeds merely falling to the ground or by animals (such as birds) picking the fruit and depositing elsewhere (USFWS 1990). No wild seedlings have been documented in the literature. J. A. Steyermark reportedly grew pondberry plants from seed in a wildflower garden in Illinois for ten years before they died out (Klomps 1980a). Seed germination beneath parent plants was reported as being successful by Wright if the seeds were depressed beneath the soil surface (USFWS 1993). In addition, cleaned and stratified seed has been reportedly germinated by McCartney (in litt.) as reported by the USFWS (1993). No hybrids are currently known to occur with pondberry.

G. Reasons for Decline

Several authors have discussed the reasons behind the suspected decline of pondberry throughout its range. There are no records in the literature of pondberry's status (whether it was abundant or scarce) before modern times. However, possible reasons for the endangered status of pondberry have been presented.

1. Alteration and Loss of Habitat

The most critical threat to pondberry, as with many endangered species, is the modification and/or loss of habitat. Three factors which constitute this threat are certain timber harvesting practices, certain drainage activities, and land-clearing operations for agricultural, commercial and private development (USFWS 1993). Various problems are associated with timber-harvesting activities such as heavy equipment crushing plants, felled trees crushing plants or uprooting adjacent trees, opening closed or dense forest canopies, and possible changes in the hydrology. Kral (1983) reported that single tree selection harvesting in hardwoods would likely not affect pondberry, while clear cut harvesting could potentially increase flood water levels to a detrimental degree. Within the Delta National Forest in Mississippi, the U.S. Forest Service, along with the USFWS, determined that a 100-foot undisturbed buffer around known pondberry colonies along with a 40-acre size limit on clearcut openings would prevent any major changes in hydrology and maintain an adequate crown closure around a colony (Banker and Goetz 1989).

Several authors have made general statements about drainage activities and subsequent effects on pondberry. Drainage from ditching may possibly "...alter the water regime in a manner that reduces the plant's vigor or eliminates it from a site" (USFWS, 1993). The general consensus appears to be that altering the wetland habitat by changing the water levels in an area is likely detrimental to the species. The USCOE (1991b) through extensive field studies of pondberry within Mississippi and consultation with various experts, determined that drainage activities which significantly alter the local hydrological regime of depressions, ponds, sinks, or other areas governed by localized hydrology would adversely affect pondberry colonies.

The third factor associated with the loss of habitat is land clearing due to agricultural interests and other developments. Throughout pondberry's range, bottomland hardwoods and similar habitat types have been extensively cleared. Within the Mississippi River alluvial valley, bottomland hardwoods decreased 56 percent, from 11.8 million acres in 1937 to 5.2 million acres in 1978 while agricultural/croplands increased nearly 5 million acres during that same time period (USFWS 1979). Habitat loss alone appears to be a major factor in the current endangered status of pondberry.

2. Disease/Predation

The literature indicates that nearly all colonies of pondberry are affected by stem die-back. Rayner and Ferral (1988) reported that stem die-back and predation were two factors that lead to poor colony health in the Honey Hill region of South Carolina. Stem die-back has been hypothesized to be fungal and/or drought related but could be characteristic of the species. Predation has been observed by deer and insects, mainly the spicebush swallowtail caterpillar (Rayner and Ferral 1988; and USCOE 1991a).

Through field studies of pondberry colonies in Mississippi, stem die-back and insect damage seem to influence the poor health of many colonies (USCOE 1991a). Will McDearman with the Mississippi Museum of Natural Science is currently conducting a four-year demographic and pathologic study on pondberry populations in the central portion of the DNF, Mississippi. Preliminary results indicate that pondberry die-back may result from a pathogen similar to one that affects soybeans resulting in late summer sudden death. Larger pondberry plants are apparently somewhat resistant to the pathogen; however they eventually succumb and die-back. Smaller plants (less than 1 meter in height) tend to exhibit die-back within the first year infested (McDearman 1993). McDearman has also noted differences in pondberry's susceptibility to the pathogen based on topographic position. Initial results of colonies studied indicate that colonies on ridge sites are more susceptible to the pathogen than colonies within "sump" or depressed (swale) areas on the DNF. However, the presence of the pathogen within colonies in the sump areas increased during the past year's monitoring. According to Mr. McDearman, conclusions about pathogen occurrence in relation to topographic position are preliminary and long-term monitoring is needed before definitive conclusions can be reached (McDearman 1993).

3. Lack of Reproduction

Most recent accounts and studies of pondberry list poor sexual reproductive success as another important reason in the decline of pondberry colonies. Many of the colonies studied in Mississippi consisted mainly of male plants and some entire colonies contained only male stems. Consequently, colony expansion is suspected to occur primarily vegetatively. Sexual reproduction can be accomplished in a controlled environment (such as a nursery) as reported by the USFWS (1990), which indicated successful seed germination when seeds were depressed below the soil surface. During recent field surveys of the Mississippi population on DNF, numerous apparently viable seeds were observed on plants although no germination from the previous years fruits was observed. With the abundance of suitable habitat within the DNF, it is likely that if germination and sexual reproduction can occur in the wild, it could be occurring here. However, reports by Tucker (1984) and Morgan (1983) indicated that germination and new seedling establishment may not occur in the wild. Therefore, population without man's intervention may depend on expansion of established clones. However, long term monitoring of known colonies and adjacent areas is needed to determine if new seedling establishment does not occur.

4. Other Reasons for Decline

Other potential reasons for decline such as grazing and trampling by cattle and hogs, changes in climatic conditions, and severe winter stress noted in Missouri and Arkansas populations have been reported (Federal Register 51(147):27495-27500; USFWS 1993). Also, the recent discovery by Steve Leonard of a weevil (*Heilipus squammosus*) associated with the dying twigs of pondberry, may have an effect on pondberry (USFWS 1993).

III. BIG SUNFLOWER RIVER MAINTENANCE PROJECT

A. Project History

Following the 1927 flood of the Mississippi River, the Federal Government initiated the Flood Control Act of 15 May 1928. Subsequent legislation modified the 1928 Act and resulted in the development of the Mississippi River and Tributaries Project. Included in this project were three separately authorized major projects that affected the Yazoo River Basin:

(1) Yazoo Backwater Project - authorized by the Flood Control Act of 18 August 1941; provided protection against backwater floods of the Mississippi River;

(2) Yazoo Headwater Project - authorized by the Flood Control Act of 15 May 1928 and subsequent amendments; provided protection against headwater floods of streams in the Basin; and

(3) Big Sunflower River Basin Project - authorized by the Flood Control Act of 1944; provided for channel improvement for flood control in the alluvial valley of the Mississippi River.

The primary purpose of the Big Sunflower River Project was to alleviate flooding in the basin area through channel improvements on the Big Sunflower, Little Sunflower, Hushpuckena, and Quiver Rivers and their tributaries, and on Hull Brake-Mill Creek Canal, Bogue Phalia, Ditchlow Bayou, Deer Creek, and Steele Bayou. Subsequent modifications altered the project to include upstream and downstream extensions, improvements to Gin and Muddy Bayous, expanded work on Steele Bayou, Main Canal and Black Bayou, and water control structures in nine lakes for fish and wildlife purposes (USCOE 1975).

The Big Sunflower River Project encompasses approximately 2,100 square miles of alluvial plain (Delta). The area is drained primarily by Steele Bayou, Deer Creek, Bogue Phalia, and the Quiver and Big and Little Sunflower Rivers and their tributaries (USCOE 1975). The original plan provided for modification of 592 miles of channel on these rivers and streams. All of the original modifications have been completed as has some additional work on Steele Bayou (and tributaries), and Gin and Muddy Bayous.

B. Proposed Operation and Maintenance Project Alternatives

1. General

The proposed Big Sunflower River maintenance project consists of sediment removal and vegetation control on all or parts of the Big Sunflower River, Little Sunflower River, Bogue Phalia, Bogue Phalia Cutoff, Holly Bluff Cutoff, and Dowling Bayou south of Highway 82 to their confluence with the Yazoo River. Figure 1 illustrates the location of the proposed maintenance project. Current stages within the areas of proposed maintenance work are one to three feet above the 1962 design flow line due to vegetation growth and sedimentation (USCOE 1993a). The proposed maintenance work would restore channel capacities to the 1962 postproject flow line, reducing headwater flooding. The proposed maintenance work will not reduce the frequency or duration of backwater floods (USCOE 1993b).

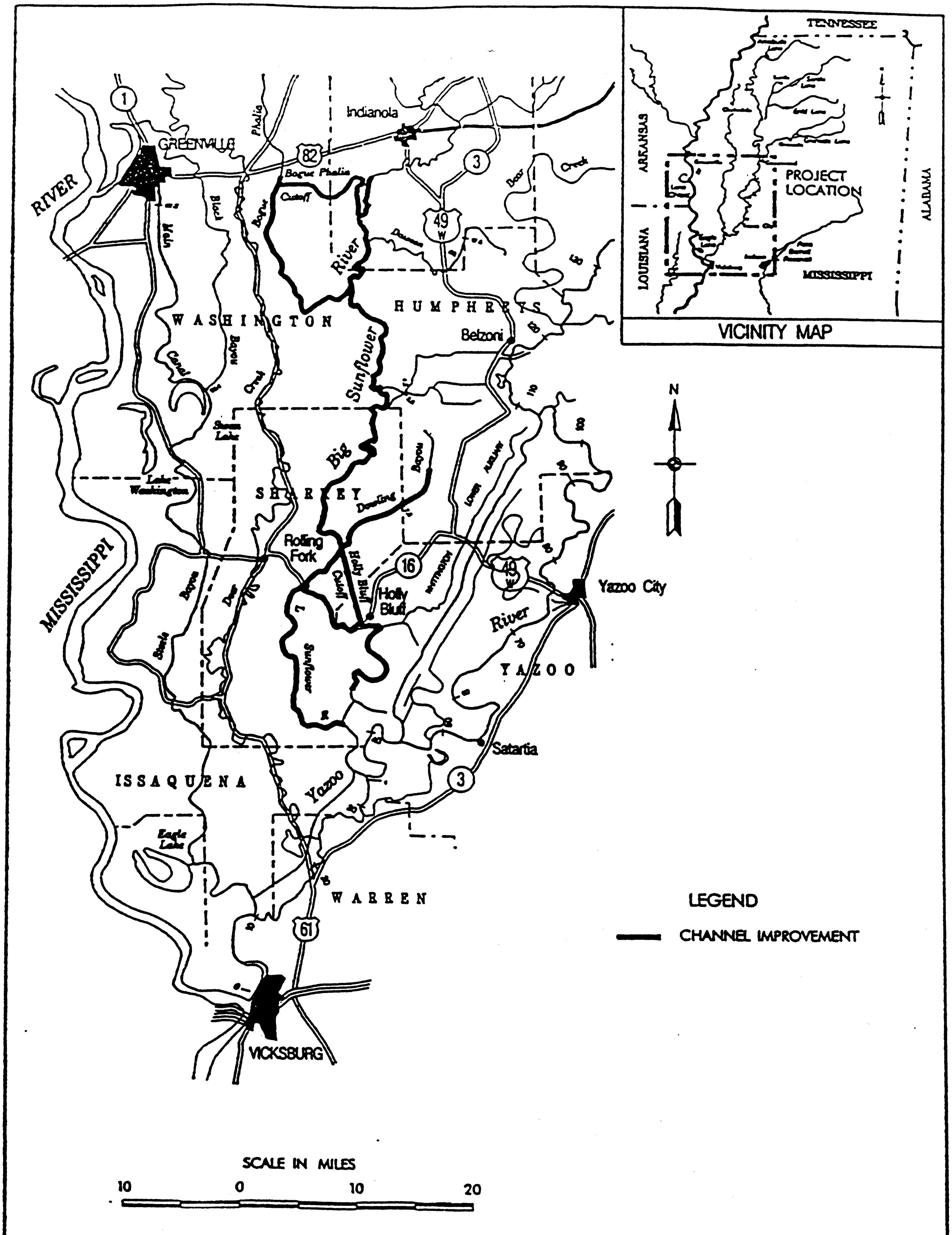

Figure 1. Location of Proposed Maintenance Project, Big Sunflower River, Mississippi.

2. Maintenance Alternatives

Four alternative plans are being evaluated for the proposed maintenance work. These four alternative plans include (1) the use of a hydraulic dredge for entire work, (2) the use of a dragline for entire work, (3) the use of a combination of hydraulic dredge and dragline to complete entire work, and (4) no action. Regardless of the action alternative used, approximately 8.42 million cubic yards of sediment is estimated to be excavated.

a. Hydraulic Dredge

Through the use of a hydraulic dredge, the 8.42 million cubic yards of sediment excavated from the channels would be pumped to confined disposal areas (CDF). The CDFs will be setback from channel banks and located to minimize the acres of forested land cleared and cotton land purchased.

b. Dragline

This alternative involves excavating the entire 8.42 million cubic yards of material from the channels by dragline and depositing the excavated material along the edge of the channel. The excavated material would be setback a minimum of 50 feet from top bank in strips approximately 150 feet wide. This requires clearing a 150-foot wide area from top bank along the entire length of channel requiring maintenance work.

c. Preferred Alternative

The preferred channel maintenance work alternative involves a combination of hydraulic dredging and dragline to excavate 8.42 million cubic yards of material. A hydraulic dredge will be used to excavate 7.75 million cubic yards, and a dragline will be used to excavate 0.67 million cubic yards. CDFs and TLD will be utilized as described in the hydraulic dredging alternative. Generally, the dragline will be used where ROW currently exists, where channels are too shallow to float a dredge/barge, or, where numerous, low clearance, bridges make it uneconomical to operate a hydraulic dredge.

C. Impacts of the Proposed Operation and Maintenance Project

The potential impacts of the proposed maintenance project that were studied in this BA include land use conversion (direct) impacts and hydrologic impacts. The following paragraphs quantify the expected conversion and hydrologic impacts.

1. Land Use Conversion Impacts

Land use conversion impacts are comprised of (1) rights-of-way (ROW) clearing and associated spoil disposal and (2) confined disposal area establishment and associated spoil disposal. Table 1 gives the acres of cleared agricultural land and forested land (bottomland hardwood) anticipated to be adversely impacted for the three action alternatives under consideration (USCOE 1993a).

Table 1. Land Use Conversion Impacts Associated with the Proposed Maintenance Alternatives.

Alternative					
Hydraulic Dredge		Dragline		Preferred Alternative	
(Acres)		(Acres)		(Acres)	
cleared	forested	cleared	forested	cleared	forested
1231	160	980	1062	1017	443

2. Hydrologic Impacts

The proposed maintenance work will reduce the average daily acres flooded within the two-year floodplain of the maintenance area. In the DNF area above Holly Bluff, the hydrologic impact of the proposed maintenance work would be a 2-3 day reduction in headwater flood duration; backwater flooding frequency is expected to be the same as pre-maintenance conditions. The hydrologic impacts resulting from the proposed maintenance work are the same for each action alternative.

According to data provided by the USCOE (1993a), the average daily acres of flooded forested wetlands (bottomland hardwoods) within the two-year floodplain of the project area will be reduced by 1,989 acres with implementation of the maintenance project. Most important to this study, annual and other "frequent" flooding of areas governed by local hydrology will occur with the same pre-project frequency (USCOE 1993b).

IV. SURVEY METHODS AND RESULTS

A. Survey of the Big Sunflower River Project Area

Field surveys for pondberry were conducted in the Big Sunflower River project area to locate any unknown colonies and to determine potential impacts that may be caused by the construction and maintenance project. The directly impacted rights-of-way (ROW) areas along the affected waterways were surveyed as well as several off channel tracts that may be indirectly impacted.

1. ROW Surveys

ROW surveys consisted of 100 percent coverage of suitable habitat within a 400-foot corridor on both banks of the following waterbodies or portions of waterbodies: (1) the Bogue Phalia from the northern limit of work (just south of Highway 82) to its confluence with the Big Sunflower River; (2) the Bogue Phalia Cutoff (including a portion east of Lakewood Cemetery) to its confluence with the Big Sunflower River; (3) the Big Sunflower River from the northern limit of work south to Six Mile Cutoff; (4) the Little Sunflower River from its origin to Six Mile Cutoff; and (5) the entire reach of Holly Bluff Cutoff (See Figure 1).

a. Area Surveyed

Corridors consisting of 200-foot ROW areas (foot print areas) and 200-foot buffer zones adjacent to the potential ROW areas were 100 percent surveyed for pondberry. The surveys were conducted only where appropriate habitat (bottomland hardwood communities) was available. Agricultural fields and croplands were not surveyed.

b. ROW Survey Methods

All survey team members visited known colony sites on the DNF to develop a visual image and become familiar with pondberry's flowering status and other identifiable features at the time of the survey. Members were also familiarized with the growth pattern, profile, and preferred habitat of pondberry.

To facilitate sampling the corridor, survey team members were assembled into four-man teams. Each team walked parallel transects the length of the corridor. The distance between each transect varied with shrub density but was no more than 80 feet apart. Generally, four transects produced 100 percent coverage of the 400 foot wide corridor. In areas where the shrub layer was dense (i.e. visibility less than 50 feet) additional transects were walked to give complete coverage. Each four-man team maintained field notes of the cover types present in each community surveyed and recorded notes of any significant observations. Each team also had copies of USGS topographic maps (scale 1:24,000) to delineate the area surveyed and precisely record the location of a discovered colony or other significant observation. If a new colony was found within the 400-foot corridor, notes were made concerning colony size (m^2), number of stems (male and female), average height of stems, and apparent condition.

c. ROW Survey Results

Two pondberry colonies were located during the ROW surveys. A colony previously located by DNF personnel was noted on the left descending bank of Holly Bluff Cutoff in the southwest corner of Dowling Greentree Reservoir. The colony was not located in the corridor but was adjacent to the area surveyed.

The second colony was located on the right descending bank of the Big Sunflower River near Fifteen Mile Island approximately 0.75 mile east of the town of Kearney. This colony is located in the ROW corridor on a high ridge of the rivers' natural bank at an elevation of 93.110 feet NGVD.

2. Off Channel Tracts

a. Area Surveyed

The project scope required a one percent (80 acres) survey of off-channel forested tracts located north of the DNF which had high potential for pondberry occurrence. GMI surveyed six tracts totaling 173 acres.

b. Off Channel Survey Methods

Survey teams were composed of two to four persons. Each team walked parallel transects 50 to 100 feet apart depending on shrub density. Transects were generally oriented perpendicular to the prevailing topography and resulted in a rectangular survey area. As in the ROW surveys, each team maintained field notes of the cover types present and recorded notes of any significant observations. Each team also had copies of USGS topographic maps (scale 1:24,000) to delineate the area surveyed and precisely record the location of a discovered colony or other significant observation. If a colony was found, notes were to be made concerning colony size (m^2), number of stems (male and female), average height of stems, and apparent condition.

c. Off Channel Survey Results

Although some potential habitat was observed in the off channel tracts, no pondberry plants were observed by GMI's field teams.

B. Survey of Upper Steele Bayou and Upper Yazoo River Basins

GMI previously conducted surveys for pondberry in the Steele Bayou basin and in the Upper Yazoo basin in 1991. The areas surveyed included the ROW along a 25.3 mile reach of Main Canal and a 36.5 mile stretch of Black Bayou. All ROW areas within the Upper Yazoo Project area were surveyed. No observations of pondberry were recorded during the Steele Bayou basin or Upper Yazoo Project area surveys. However, since these surveys were completed, the USFWS has requested additional survey efforts within other off-channel tracts.

As part of the Big Sunflower River project, GMI was tasked to conduct off-channel tract surveys of both the Steele Bayou and Upper Yazoo basins. This effort was designed to provide a one percent (330 acres) survey within 21 forested off channel tracts in the Upper Yazoo Project area and a survey of six off-channel tracts in the Upper Steele Bayou basin. Based on a pondberry profile developed by the District (USCOE 1991a) as well as GMI's experience with the ecological requirements of pondberry, forested tracts with a high potential for pondberry occurrence were selected for surveying.

1. Area Surveyed

Six tracts were surveyed for pondberry in the Steele Bayou basin in March 1993. A total of 170 acres were surveyed. In the Upper Yazoo River basin 21 forested tracts were surveyed comprising a total of 500 acres.

2. Survey Methods

Survey methods were the same as those used in surveying the Big Sunflower River off-channel tracts with each team consisting of three to four professional biologists.

3. Survey Results

Although some apparent potential habitat was observed in the Upper Steele Bayou basin, no pondberry plants were noted by GMI's field teams. Surveys performed in the Upper Yazoo projects area resulted in the discovery of a single new colony. The colony is located on private lands in Tallahatchie County and consists of six female stems. The average height of the stems is approximately 30 cm. The individual stems are healthy but the status of the overall colony appears poor.

This colony, like most colonies on the DNF, is located in a ridge and swale bottomland hardwood community. It is situated on the side slope of ridge at an elevation of 150.3 feet National Geodetic Vertical Datum (NGVD) which is just above the 100-year floodplain of the Upper Yazoo River basin. The colony is adjacent to a small (0.1 acre) depression located downslope of the colony. Local ponding would provide any annual or other frequent flooding at this site. The associate species at this colony site include sugarberry, American elm, boxelder (*Acer negundo*), sweetgum, spicebush, roughleaf dogwood, red mulberry, American snowbell, water oak, blackgum, Virginia creeper (*Parthenocissus quinquefolia*), common greenbrier (*Smilax rotundifolia*), blackberry (*Rubus* sp.), ladies' eardrop (Brunnichia cirrhosa), poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), dayflower (*Commelina* sp.), and boneset (*Eupatorium* sp.).

V. IMPACT ASSESSMENT OF THE PROPOSED BIG SUNFLOWER MAINTENANCE WORK

A. Direct Impacts

No direct adverse impacts would occur to pondberry upon implementation of the proposed maintenance project provided the following stipulations are observed:

(1) Bank clearing work on Holly Bluff Cutoff for dragline access must be conducted on the right descending bank, (as planned) especially near the northern end of Holly Bluff Cutoff. This will avoid any direct impacts to a pondberry colony located in Dowling Greentree Reservoir located on the left descending bank of Holly Bluff Cutoff.

(2) The spoil disposal area on the right descending bank of the Big Sunflower River adjacent to a forested bend near Fifteen Mile Island should be moved to the left descending bank and completely situated in a cleared area. This will avoid any adverse direct impacts to a pondberry colony located on the southwestern tip of the forested bend on the river's natural bank approximately 0.75 mile east of the town of Kearney.

B. Hydrologic Impacts

Past field investigations (USCOE 1991a) determined that the majority (87 percent) of the extant pondberry colonies on the DNF are located at an average elevation of 95 feet NGVD based on USGS topographic map location. The USCOE also obtained elevations surveyed from established benchmarks for 13 pondberry colonies located in the northern portion of DNF which ranged from 94.5 - 98 feet NGVD and averaged 96.7 feet NGVD. This area where the 13 colonies are located in the northern portion of the DNF corresponds with Holly Bluff water gage data. According to these data, the colony at the lowest elevation is inundated by overbank flooding once every six to seven years and the colony at the highest elevation is subject to overbank flooding once every 43 years. On average, the 13 pondberry colonies are subject to overbank flooding once every 20 years.

In a meeting on the potential impacts of the proposed maintenance project on pondberry (Appendix B), the USFWS expressed concerns that some pondberry colonies (especially some colonies in the southern portion of DNF discovered since 1991) may be located at elevations below the 94.5 foot minimum elevation of the 13 colonies studied by the USCOE in 1991. According to the USFWS, such colonies may undergo more frequent overbank flooding than the 13 colonies surveyed by the USCOE (1991). The USFWS requested that the USCOE obtain elevations for additional pondberry colonies (especially recently discovered colonies) in other portions of the DNF. Subsequently, the USCOE requested locations of all known pondberry colonies on the DNF from the U.S. Forest Service. The USCOE also requested a summary of the total acreage that has been surveyed for pondberry on the DNF, to date. Accordingly, the U.S. Forest Service has surveyed approximately 6,840 acres on the DNF.

From 29 January 1994 to 18 February 1994, the USCOE conducted elevation surveys for all known pondberry colonies on the DNF which had not been previously surveyed in 1991. As previously mentioned, elevations were obtained for 13 of the 41 colonies on the DNF investigated by GMI in 1991. The survey crew attempted to locate and obtain elevations for the 28 pondberry colonies not surveyed in 1991 and any new colonies discovered by the U.S. Forst Service since 1991. The USCOE also surveyed three colonies located on private lands in Sunflower County near Merigold, Mississippi. GMI biologists assisted the survey crew in locating and identifying pondberry colonies on the DNF. As a result of the USCOE survey efforts, elevations were obtained for 25 sites on the DNF that were not surveyed in 1991 by the USCOE, 19 of which are located above the Holly Bluff samplng station. The other six colonies are located downstream of the Holly Bluff sampling station. Elevations were not able to be obtained for some pondberry colonies because they were either inaccessible due to high water or were not able to be relocated. A summary of the USCOE elevation surveys is presented in Table 2. The sampling stations which have gage data representative of overbank flooding conditions for each colony site are also presented in Table 2. The USCOE stream gage data for the three sampling stations are given in Appendix B.

As evident in Table 2, the lowest colony elevation within the area of the DNF corresponding with the Holly Bluff sampling station is 91.576 feet NGVD and the highest colony elevation is 98.046 feet NGVD; the average elevation of 19 sites is 95.313 feet NGVD. According to the Holly Bluff gage data, the colony at the lowest elevation (C19) is within the two-year floodplain and has flooded 26 out of 43 years on record. None of the 13 colonies surveyed in 1991 are within the two-year floodplain. The colony at the highest elevation has flooded only once out of 43 years on record, while a site at the average elevation has flooded seven out of 43 years on record. Within the portion of the DNF representative of the gage data from the 'Yazoo River at the mouth of the Big Sunflower River' sampling station, the lowest colony elevation is 88.583 feet NGVD and the highest colony elevation is 94.092 feet NGVD (average elevation of five sites is 91.956 feet NGVD). The lowest colony has flooded 22 out of 31 years on record, the colony at the highest elevation has flooded seven out of 31 years on record, while a site at the average colony elevation has flooded 11 out of 31 years on record. Within the area of the DNF representative of gage data from the 'Little Sunflower River Control Structure Intake' sampling station, only one colony exists. This colony has an elevation of 87.650 feet NGVD and has flooded eight out of 13 years on record.

For areas of the DNF below Holly Bluff (areas corresponding with the 'Yazoo River at the mouth of the Big Sunflower River' and 'Little Sunflower River Control Structure Intake' sampling stations), hydrology impacts will be negligible. In the DNF area above Holly Bluff (area corresponding with the Holly Bluff sampling station), the hydrologic impact of the

Table 2. Results of the USCOE Pondberry Elevation Surveys.

SITE	Elevation (ft. NGVD)		Representative Stream Gage Data Location
003	96.405		Big Sunflower at Holly Bluff, MS.
003A	95.128		Big Sunflower at Holly Bluff, MS.
007	97.530	98.046	Big Sunflower at Holly Bluff, MS.
009	"	"	Big Sunflower at Holly Bluff, MS.
010	"	"	Big Sunflower at Holly Bluff, MS.
013	97.617		Big Sunflower at Holly Bluff, MS.
014	94.511		Big Sunflower at Holly Bluff, MS.
015	94.399		Big Sunflower at Holly Bluff, MS.
016	94.565		Big Sunflower at Holly Bluff, MS.
017A	94.511		Big Sunflower at Holly Bluff, MS.
017B	94.399		Big Sunflower at Holly Bluff, MS.
019	95.598		Big Sunflower at Holly Bluff, MS.
023	94.481		Big Sunflower at Holly Bluff, MS.
024	96.436		Big Sunflower at Holly Bluff, MS.
035	95.338		Big Sunflower at Holly Bluff, MS.
036	94.971		Big Sunflower at Holly Bluff, MS.
042	94.773		Big Sunflower at Holly Bluff, MS.
043	94.773		Big Sunflower at Holly Bluff, MS.
C19	91.576		Big Sunflower at Holly Bluff, MS.
C21	95.895		Big Sunflower at Holly Bluff, MS.
C28	88.583		Yazoo River at the mouth of the Big Sunflower
030	90.603		Yazoo River at the mouth of the Big Sunflower
C39	93.110		Yazoo River at the mouth of the Big Sunflower
C47	94.092		Yazoo River at the mouth of the Big Sunflower
C47A	93.393		Yazoo River at the mouth of the Big Sunflower
C48	87.650		Little Sunflower River Control Structure Intake

proposed maintenance work would be a 2-3 day reduction in headwater flood duration within the two-year floodplain of the Big Sunflower River. The 2-year floodplain habitat of the Big Sunflower maintenance project area would be reduced by 1,989 acres (bottomland hardwoods). Backwater flooding frequency in the lower Big Sunflower River Basin is expected to be the same as pre-project conditions. Pondberry colony C19 is within the two-year floodplain of the Big Sunflower River but it is located in the Sunflower Greentree Reservoir where flooding is controlled by the U.S. Forest Service. The current flooding regime will not be altered and this colony will not be impacted by the proposed maintenance project. According to pondberry elevation data and historical hydrologic data for the Big Sunflower River, an average pondberry colony is located within the 6- to 7-year floodplain of the Big Sunflower River basin. Thus, a reduction in the 2-year frequency floodplain should not alter the frequency and duration of overbank flooding that the vast majority of pondberry colonies currently experience. Pondberry experts who attended a workshop in December 1990 agreed that local hydrology was probably more important to the growth and health of pondberry than was overbank flooding (USCOE 1991b). The proposed maintenance work will not alter local hydrology (i.e., localized annual and other frequent flooding and ponding would still occur) and, thus, would not induce additional land clearing.

According to current pondberry colony elevation and flood frequency data, the proposed maintenance work will have no adverse indirect impacts to pondberry. The previously mentioned project stipulations will prevent any adverse direct impacts to pondberry. If however, potential pondberry colonies are encountered during construction, appropriate protective action should be taken (i.e., rerouting project right-of-way). In addition, if new data, information or other knowledge is produced that refutes or alters current theories about the habitat requirements of pondberry, that information should be given close consideration of its implication to the Big Sunflower River maintenance project.

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APPENDIX 1

FINAL REPORT

PONDBERRY PROFILE

ENDANGERED SPECIES STUDY

CONTRACT NO. DACW38-90-D-0003

DELIVERY ORDER NO. 12

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS

VICKSBURG DISTRICT
P. O. BOX 60
VICKSBURG, MISSISSIPPI 39181

GEO-MARINE

PREPARED BY:

GEO-MARINE, INC.

PLANO, TEXAS AND BATON ROUGE, LOUISIANA

APRIL, 1991

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PONDBERRY PROFILE

I. INTRODUCTION

This report discusses the methods and findings of the Pondberry Profile Endangered Species Study undertaken by Geo-Marine, Inc. (GMI). This report was prepared for the U.S. Army Corps of Engineers, Vicksburg District, under Contract No. DACW38-90-D-0003, Delivery Order No. 012.

Descriptions of the general project background as well as the purpose of this study are given in this section of the report. Methods adopted and utilized during the investigation are discussed in Section II. Results of the Pondberry Profile Study are addressed in Section III while Section IV presents the study's conclusions and recommendations.

PROJECT BACKGROUND AND PURPOSE

The U.S. Army Corps of Engineers, Vicksburg District, is currently undertaking a comprehensive reformulation study of the Upper Yazoo and Steele Bayou flood control projects. These projects involve various structural measures such as levee construction and channel modifications. The purpose of these measures is to reduce the area inundated by flooding. As part of the reformulation process, the Vicksburg District is analyzing all potential environmental effects, both adverse and beneficial, that are expected with each of the alternative flood control measures.

One of the potential effects is associated with the endangered plant species, pondberry (*Lindera melissifolia*). The U.S. Fish and Wildlife Service (USFWS) listed the pondberry as endangered on 31 July 1986. Since there are known pondberry locations within the Mississippi Delta Region (ie. Delta National Forest), a potential exists for proposed flood control measures to affect (adversely or beneficially) extant pondberry communities.

Therefore, the Vicksburg District, in an effort to allow an accurate assessment of potential effects, has engaged in this pondberry profile study. The overall goal of this project was to develop a profile of the pondberry's life requisites within Mississippi. The profile was to be developed through field data collected and analyzed from known pondberry colonies and from pertinent secondary sources. The profile could then be used to develop a stratified sampling scheme which could be applied to the Upper Yazoo and Steele Bayou basins.

II. METHODOLOGY

The procedures implemented in developing the pondberry profile can be grouped into three categories; 1) literature search and review, 2) expert consultation, and 3) field data collection and analysis. This section discusses the methods and procedures utilized in each category.

LITERATURE SEARCH AND REVIEW

GMI's literature search included a review of both published and unpublished documents which evaluate and describe pertinent data and known facts about pondberry. GMI's sources of published and unpublished literature included botanical and biological abstracts, university herbariums and their literature collections, the Mississippi Natural Heritage Program, the USFWS, personal consultation with university professors and the U.S. Army Corps of Engineers, Vicksburg District.

In order to obtain a broad understanding of pondberry, a wide array of information was sought such as known colony sites, associated vegetation, morphological characteristics, reproductive characteristics, associated habitats and other apparent life requisites.

An annotated bibliography of the documents reviewed is included in this report as Appendix A.

EXPERT CONSULTATION

In order to verify/refute information obtained from the literature review and to obtain additional unpublished information, persons expected to have extensive experience or interest in pondberry were consulted. Initial contact and subsequent consultation were made by telephone conversation. A list of names, telephone numbers, and addresses of those persons found to have a keen interest and/or knowledge of pondberry was then developed.

These people were consulted prior to initiating field.work for help in developing the field data sheet. In addition, the experts were invited to a workshop, conducted at the Vicksburg District, to provide a critical review of the profile developed by GMI and to form a consensus concerning potential impacts and sampling schemes for subsequent surveys. The workshop is discussed in further detail in Section IV.

FIELD DATA COLLECTION AND ANALYSIS

GMI, along with the Vicksburg District, determined that in addition to literature review and expert consultation, prudent and worthwhile methods of developing a profile of pondberry should involve an analysis of extant pondberry colonies within the Delta region of West-Central Mississippi. Numerous known colonies are found on the Delta Natural Forest (DNF) and on private lands in Bolivar and Sunflower counties, Mississippi north of the DNF.

Before attempting any fieldwork, GMI developed a list of various biological and ecological factors relevant to pondberry that could be evaluated either objectively or subjectively in the field. This list of parameters was developed through the aid of the Vicksburg District, information gleaned from the literature review, and from advice and suggestions obtained through expert consultation. After compiling an appropriate list of relevant biological and ecological factors, a field data form was developed to better facilitate data collection (Exhibit A).

As previously mentioned, data were collected from existing pondberry colonies within the DNF and on private lands in Bolivar and Sunflower counties, Mississippi. A team of three people

EXHIBIT A - Pondberry Profile Field Data Form

GEO-MARINE, INC.
PONDBERRY PROFILE FIELD DATA

Recorder:__________ Sampler(s):____________________ Date:__________

Location:________________ Colony ID : ____________ Plot Number: ________

____

Plot radius = 37 ft. (0.1 acre)

GENERAL QUESTIONS

What is the distance (ft.) to the nearest body of water? . __________
(Measure in field or determine from map)

What is the relative elevation of plot center? . . . . . . __________

What is the maximum water depth on the plot? . . . . __________

What general soil type is present? . . . . __________

What is the soil pH? . . . . __________

Stand Maturity, most trees are (circle one). 6" DBH   6-18" DBH   >18" DBH   Mixed Sizes

Is there any evidence of past disturbance near the site? . . .   Yes
(e.g. stumps from harvesting operations, beaver damage, etc.)   No

ASSOCIATED VEGETATION

Percent Canopy Coverage (Using densiometer)
North reading_____East reading_____South reading_____West reading_____
Avg. Percent Canopy Cover _____

Overstory Species

Understory Species

Shrubs and Herbaceous Species

PONDBERRY COLONY DATA

Number of clumps . . . . __________
Avg. number of stems within each clump . . . . __________
Approximate total number of stems . . . . __________
Number of female stems . . . . __________
Average height of clumps (ft) . . . . __________
Average groundline diameter of stems . . . . __________
Apparent health of colony . . . .   excellent   fair
good   poor

including an ecologist, forester, and biologist performed the data collection. Compartment maps supplied by the Forest Service and topographic maps supplied by the Mississippi Chapter of The Nature Conservancy delineating known pondberry colonies were used to facilitate colony location in the field. Because many of the colonies are in remote areas, the field team was required to conduct transects in the general vicinity in order to locate the colonies. Each colony located was thoroughly sampled by completing the field data form, given a colony ID number, and then properly mapped, if not done so, on the reference maps.

Soil samples were collected at each site (Photograph 1) and submitted to the Louisiana State University Soils Testing Laboratory (Baton Rouge) for analysis. Each soil sample was analyzed for pH, phosphorus, sodium, potassium, magnesium, calcium, percent organic matter and characterized for physical attributes (ie. silt, loam, clay, etc.)

Elevations and distance were measured using a combination of pacing, topographic map interpretation, and visual estimations. Where the latter was utilized, consensus among the field team members was required.

Canopy cover was measured with a densiometer near the center of each pondberry colony. Associate species were recorded within a 0.1 acre plot surrounding the colony center at each vegetational layer (i.e., overstory, understory, shrubs and ground cover).

With the exception of a few very large colonies, individual stems of each clump of pondberry were counted and recorded. Stems were considered an individual plant if there was no apparent connection to other stems at or near the ground surface. For this study, clumps were defined as groups of stems that were located at least 15 feet from each other.

Photograph 1. Soil sampling at pondberry colonies.

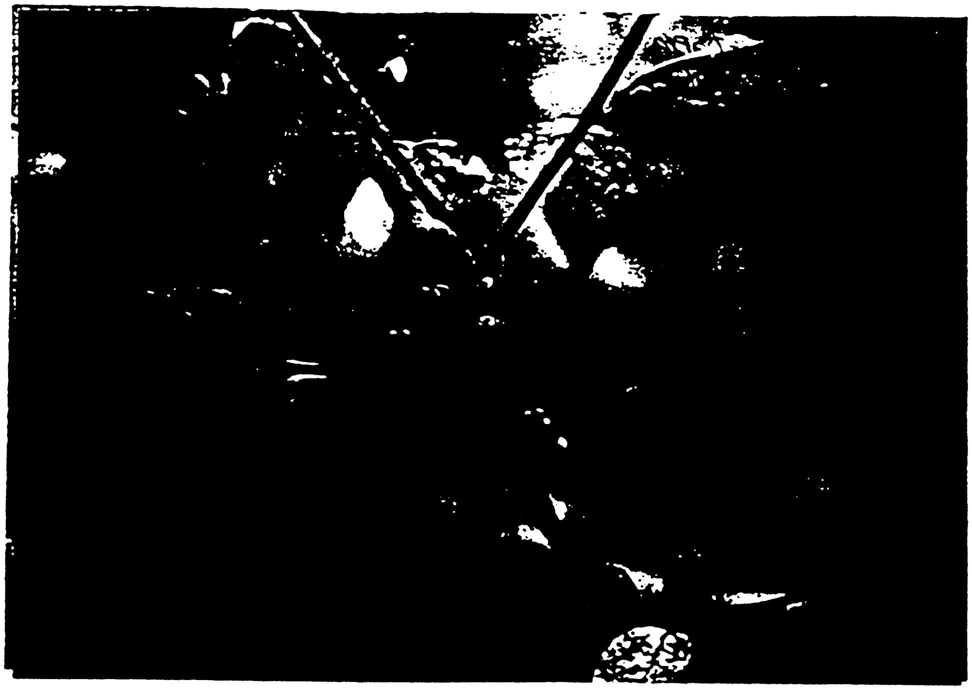
For large colonies, such as the one in the Dowling Bayou Greentree Reservoir, a 25 percent sample of the colony was counted, measured and recorded. The numbers were then extrapolated for the entire colony. However, each female stem was counted and recorded, regardless of the size of the colony. Female stems were identified by maturing fruit (Photograph 2) and/or fruit pedicels from 1990 and 1989.

The general health of the colony was a subjective value based upon the ratio of dying stems to live stems, physical appearance of the leaves and stems, the density of the colony and the magnitude of insect damage (Photograph 3).

Pertinent quantitive field data were compiled from the field data sheets and statistically analyzed using the PARADOX$_{TM}$ computer software program. The analyses performed included means and standard deviation values of each parameter as well as pair-wise correlations for all variables.

Because herbaceous species are seasonal and are not possible to accurately identify in bottomland hardwood communities using remote sensing techniques, they would lack relative importance to developing a stratified sampling scheme. Consequently, herbaceous species were not included in the statistical analysis. Similarly, most of the woody vines, such as poison ivy (Rhus radicans), trumpet creeper (Campsis radicans), and grape (Vitus spp.) were not included in the statistical analysis because of their cosmopolitan habitat requirements.

Photograph 2. Pondberry fruit.



Photograph 3. Spicebush swallowtail caterpillar (Pterourus troilus) on pondberry.

III. RESULTS OF PONDBERRY PROFILE

This section details the findings of the Pondberry Profile Endangered Species Study. The results are presented in three subsections:

1) General
2) Physical Data
3) Biological Data

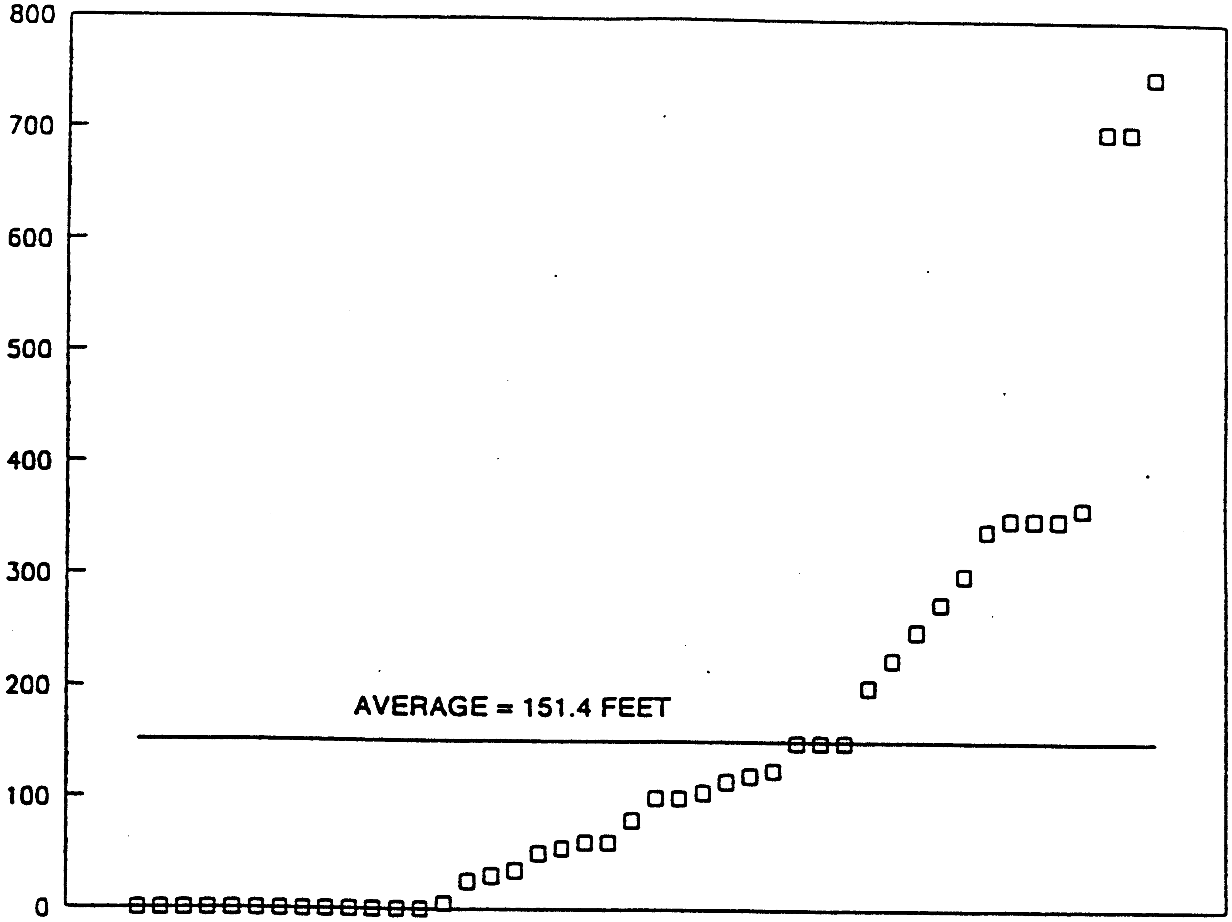
GENERAL

A total of 44 pondberry colonies were visited, only three of which were not located in the DNF. These three colonies were on private lands that supported small (less than five acres) remnant bottomland hardwood communities surrounded by croplands, primarily cotton and soybeans. The DNF is comprised of bottomland hardwoods with isolated and limited stands of cypress/tupelogum swamps.

PHYSICAL DATA

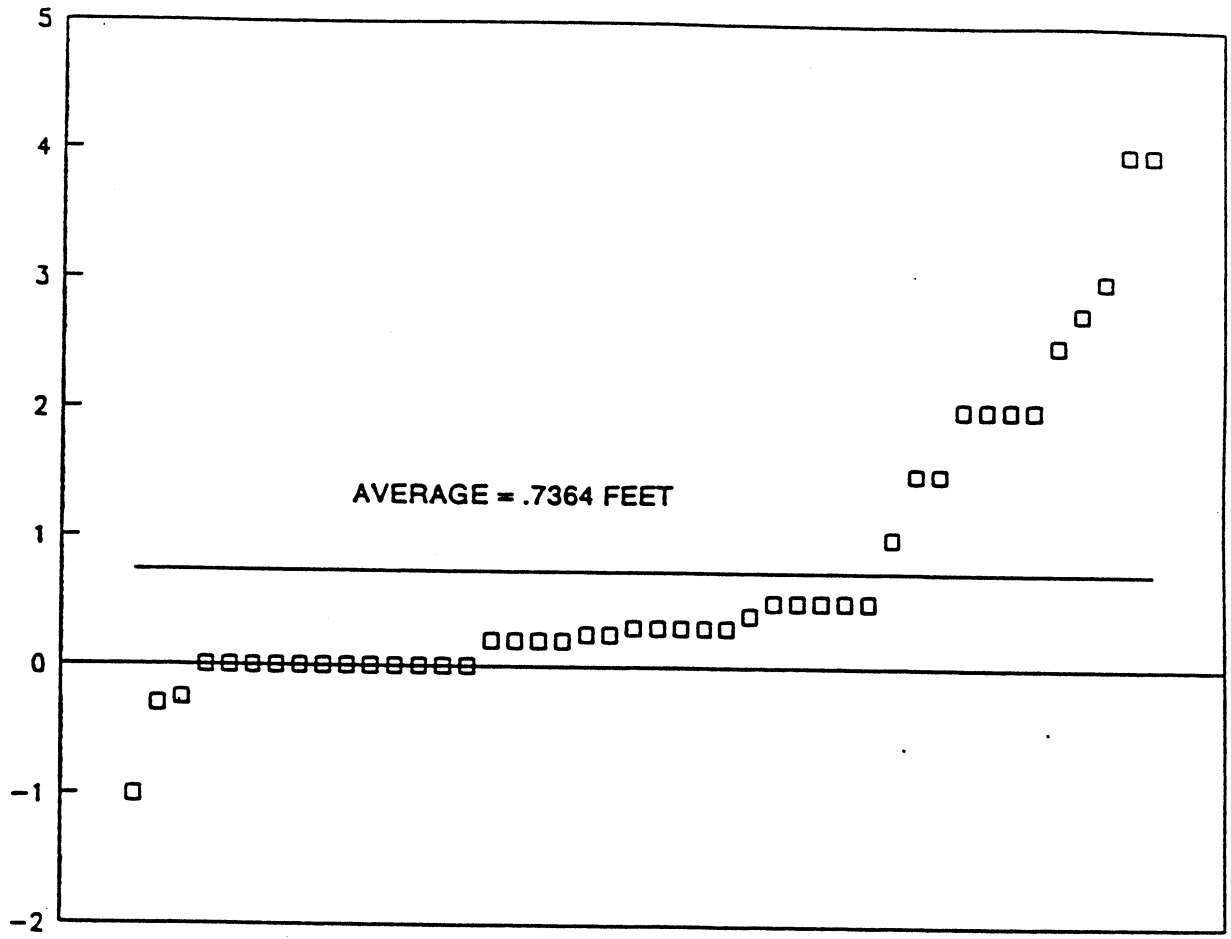
The average distance of a colony from a "permanent" or standing body of water was 151.4 feet. This distance is skewed due to three colonies which were in excess of 700 feet from a waterbody. Without these three colonies, the average distance would be 110 feet. Of the 44 colonies, 14 (32 percent) were within five feet of a waterbody. Figure 1 illustrates the distribution of each colony relative to its proximity to waterbodies.

The average elevation of the colonies, relative to the surrounding land, was 0.7 feet higher (Figure 2). Twelve colonies (27 percent) were in areas with no immediate topographic relief. Three colonies were in a slight depression area ranging from three to 12 inches lower than the surrounding land. Contrarily, nine colonies were on knolls/ridges that were two to four feet higher than the surrounding lands.



Source: GMI

Figure 1. Distance between pondberry colony and waterbody (in feet).



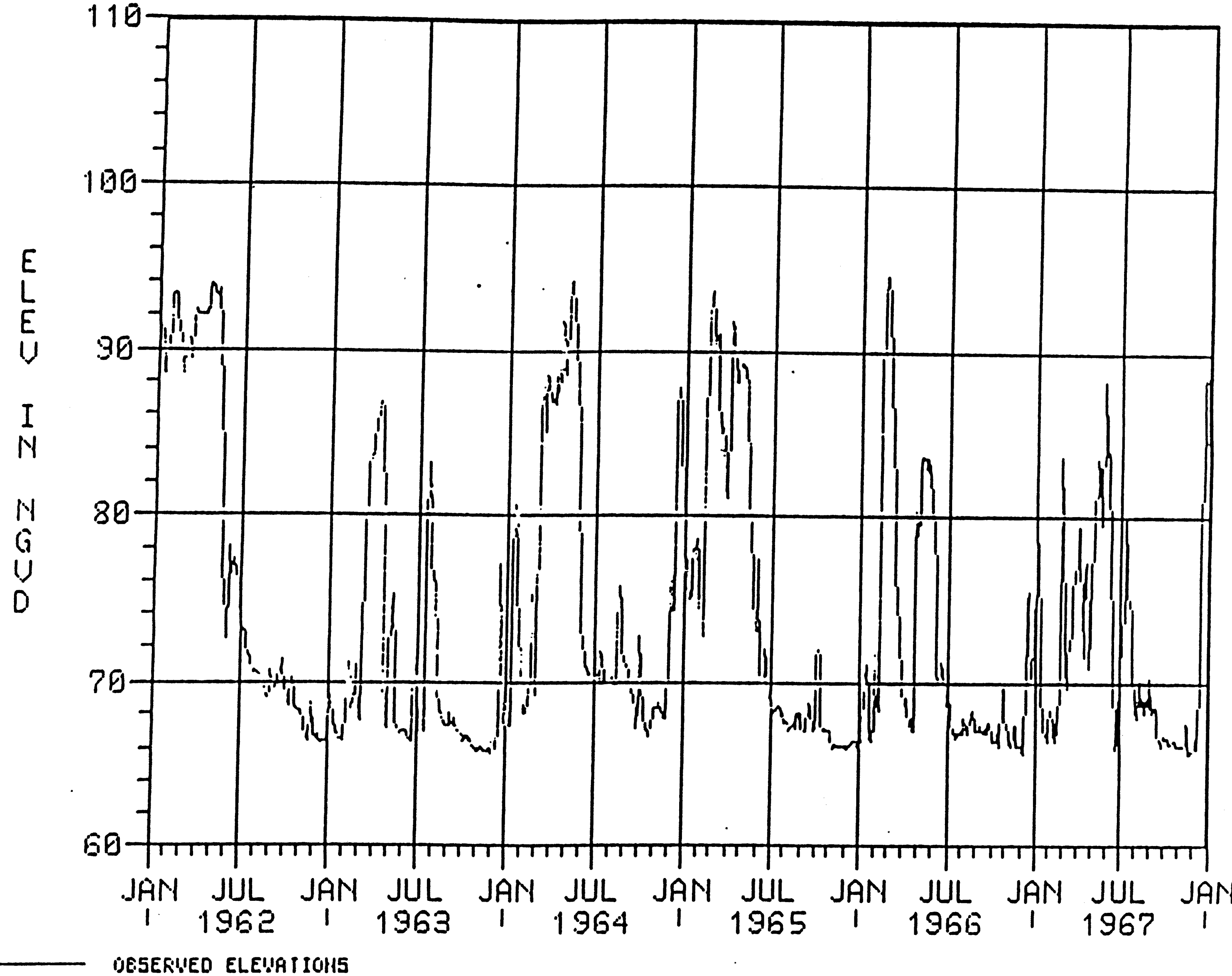
Source: GMI

Figure 2. Relative elevation of plot center for surrounding lan(
(in feet).

The approximate elevations of the 44 colonies sampled ranged from 91 to 145 feet National Geodetic Vertical Datum (NGVD). The elevation of the 39 colonies sampled on DNF ranged from 91 to 98 feet NGVD, with the average elevation of these colonies at 95.2 feet NGVD. Of the 39 colonies on DNF, 34 colonies (87 percent) were at elevations at or greater than 94 feet NGVD. This average elevation indicates that these colonies are above the 15-20 year floodplain of the Big Sunflower River, the main drainage system of the DNF. Water elevations on the Big Sunflower River for the period 1962-1990 are presented on Figure 3. As can be seen from this figure, river stages greater than 94 feet occurred only five times during the past 30 years and for very short durations during each occurrence.

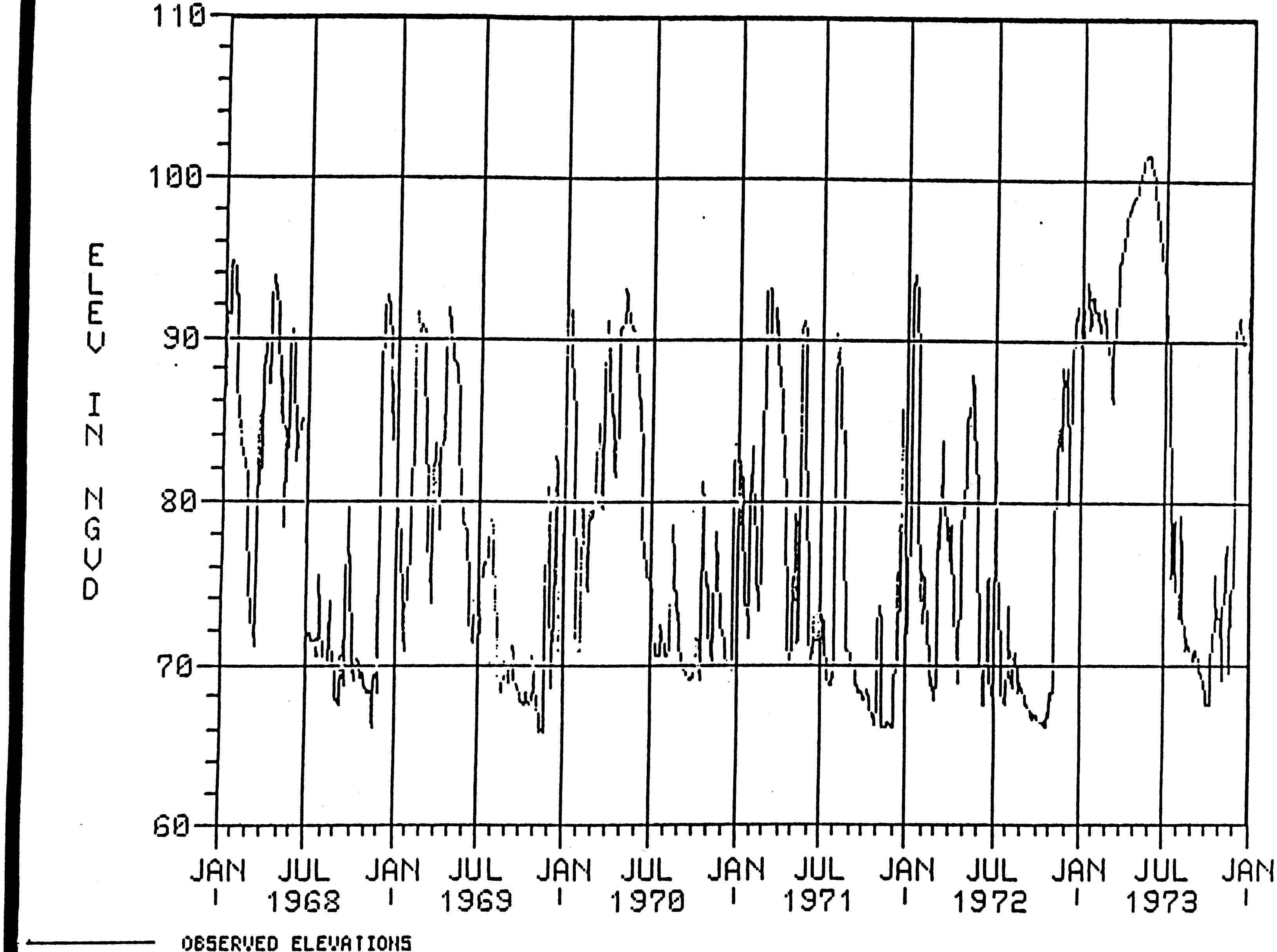
Although the majority of the colonies were in proximity to standing water and in relatively flat areas, 32 of the 44 colonies (73 percent) had no indication of standing water within the colony. The remaining 12 colonies had evidence of standing water ranging in depth from 1.5 to six inches (Figure 4).

Silt comprised a major portion of the soils at all the colony sites. Approximately 41 percent of the colonies were located in soils classified as silty clay and about 32 percent were situated in silty clay loam soils. The remaining 27 percent of the colonies were located in silt loam soils. A summary of the results of the soil chemical analyses of the 44 soil samples collected is presented in (Table 1).



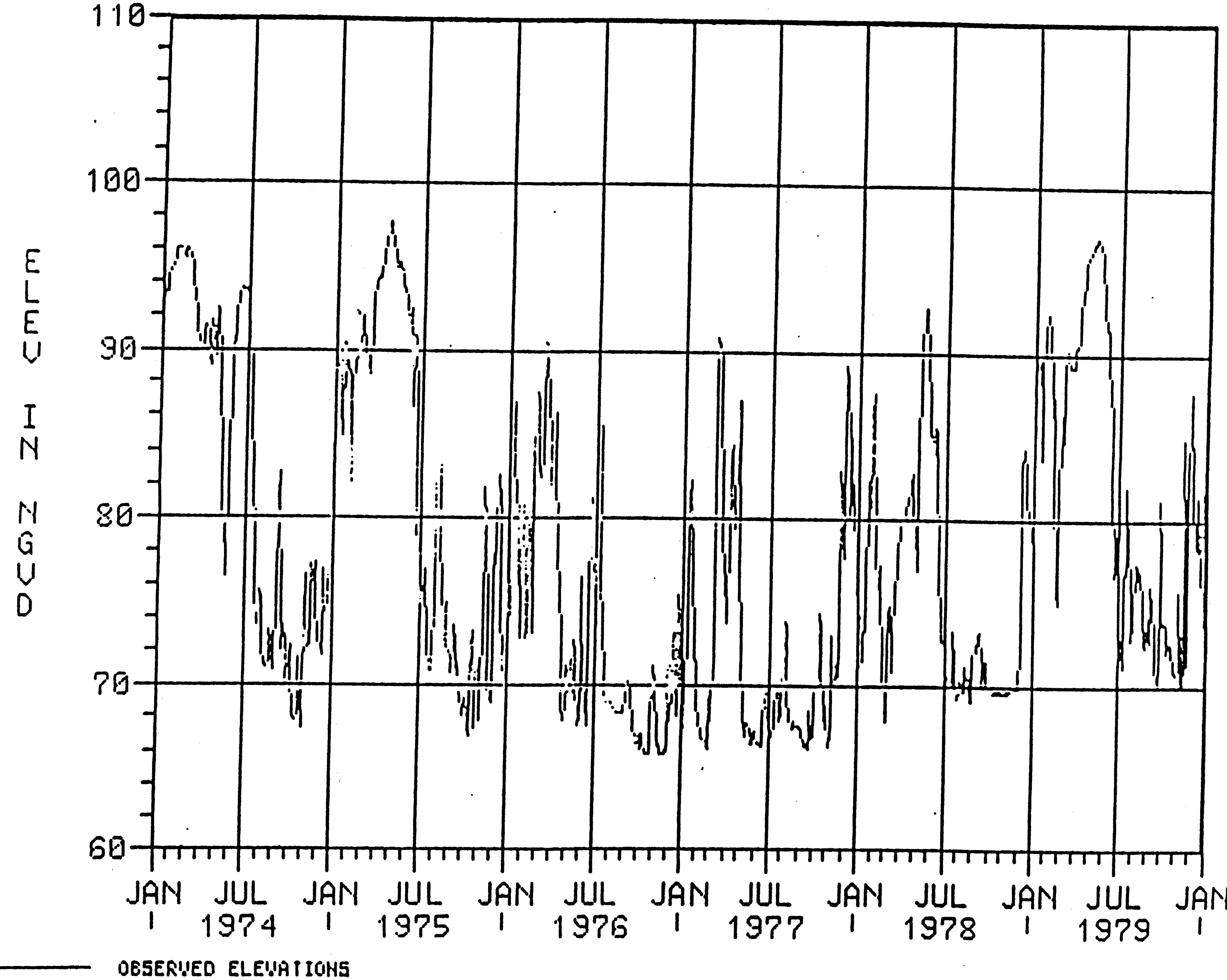
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Bi[illegible]nflower River at Holly Bluff



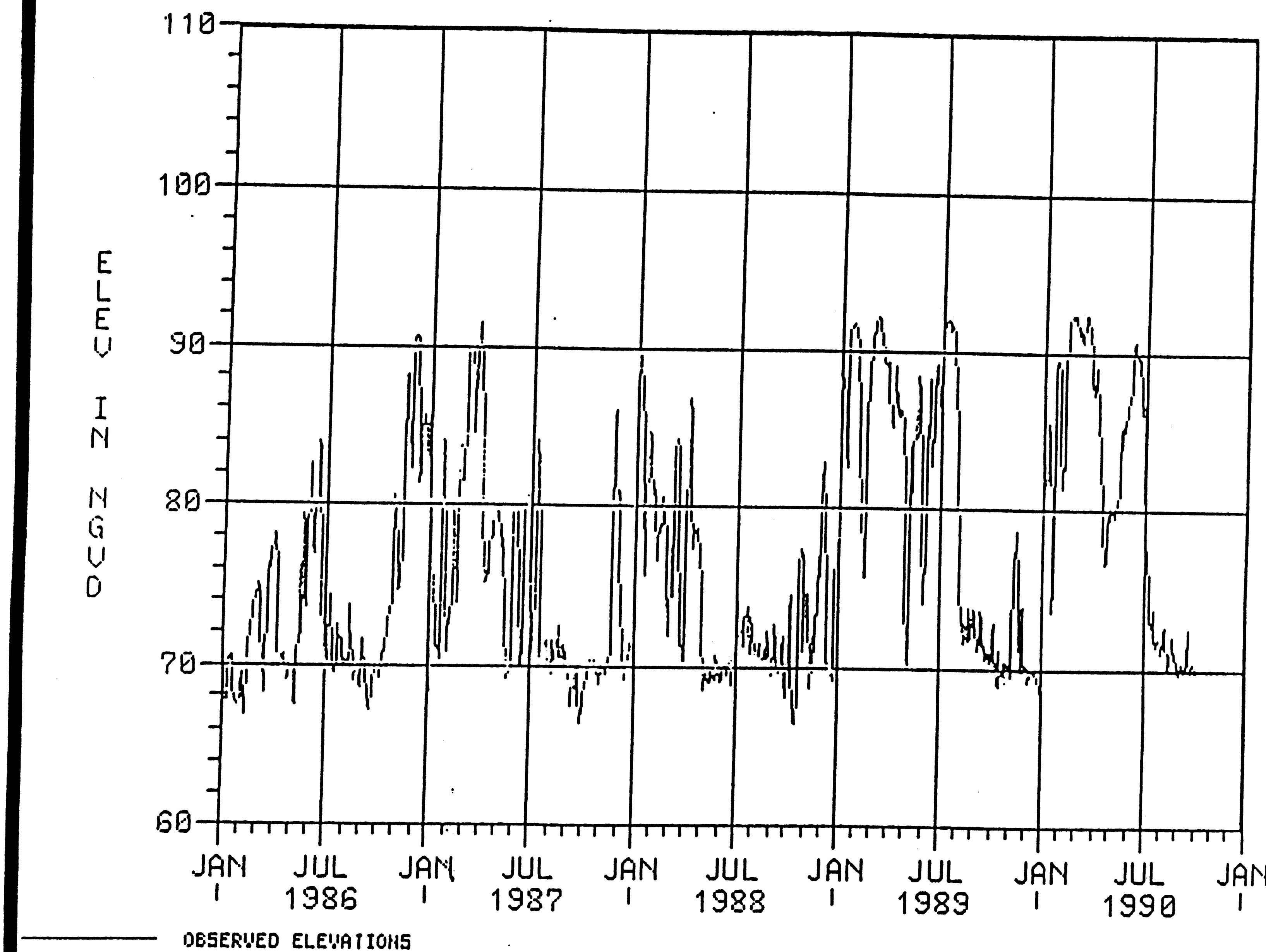
Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



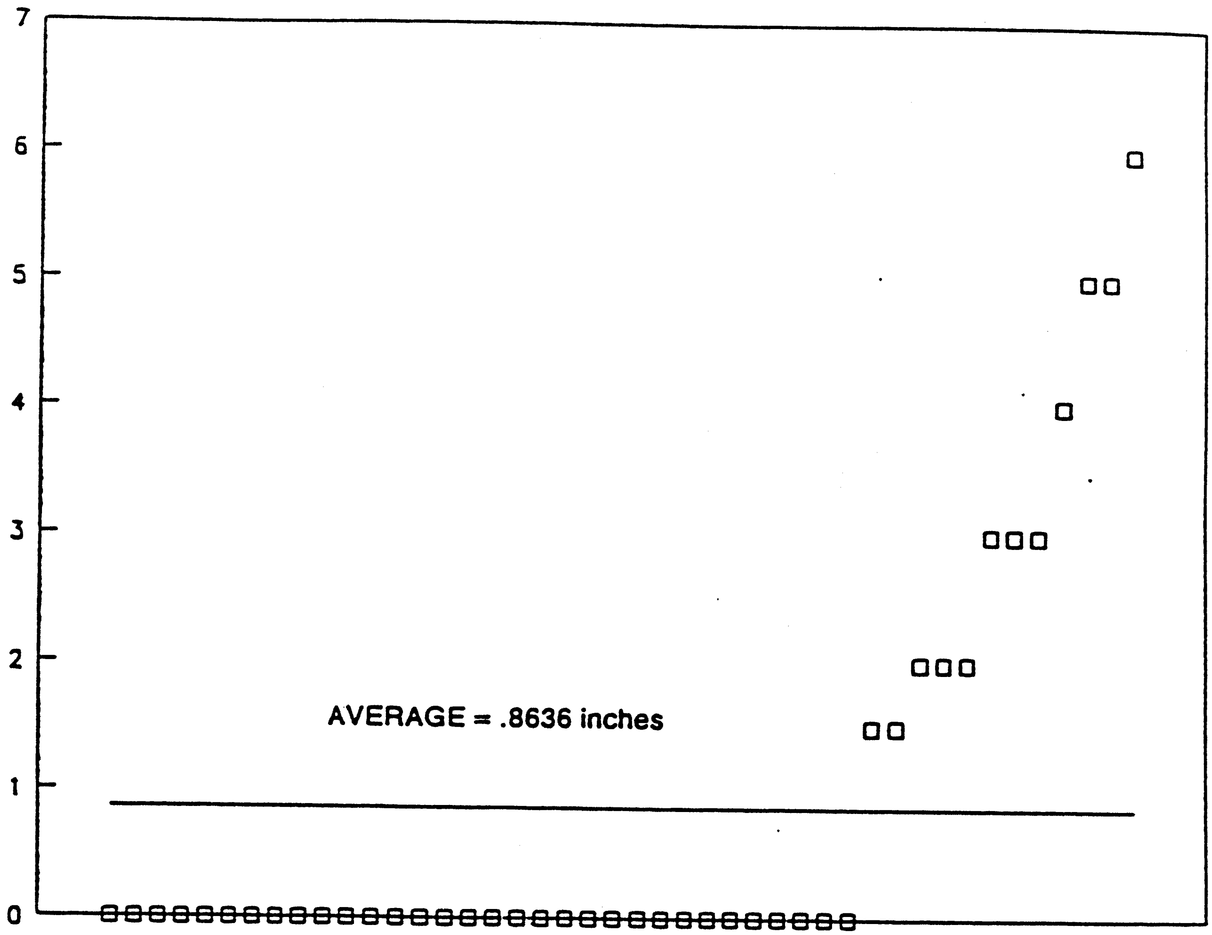
Source: U.S. Army Corps of Engin[illegible]rs, Vicksburg Dist[illegible]t.

Figure 3. River stages on Big S[illegible]ower River at Holly Bluff - Continued.



Source: U.S. Army Corps of Engineers, Vicksburg District.

Figure 3. River stages on Big Sunflower River at Holly Bluff - Continued.



Source: GMI

Figure 4. Maximum depth water on plots (in inches).

TABLE 1

Analytical Results of Soil Samples Collected at 44 Pondberry Colonies, Mississippi

	Minimum Value	Maximum Value	Average
pH	4.7	5.7	5.1
Phosphorous	38.0	359.0	129.2
Sodium	13.0	58.0	30.2
Potassium	98.0	600.0	278.4
Magnesium	334.0	1493.0	698.6
Calcium	1319.0	5228.0	2879.7
Organic matter (%)	0.6	4.5	1.8

Note: Unless otherwise specified, all units are in parts per million (ppm); pH has no units.

Source: GMI

BIOLOGICAL DATA

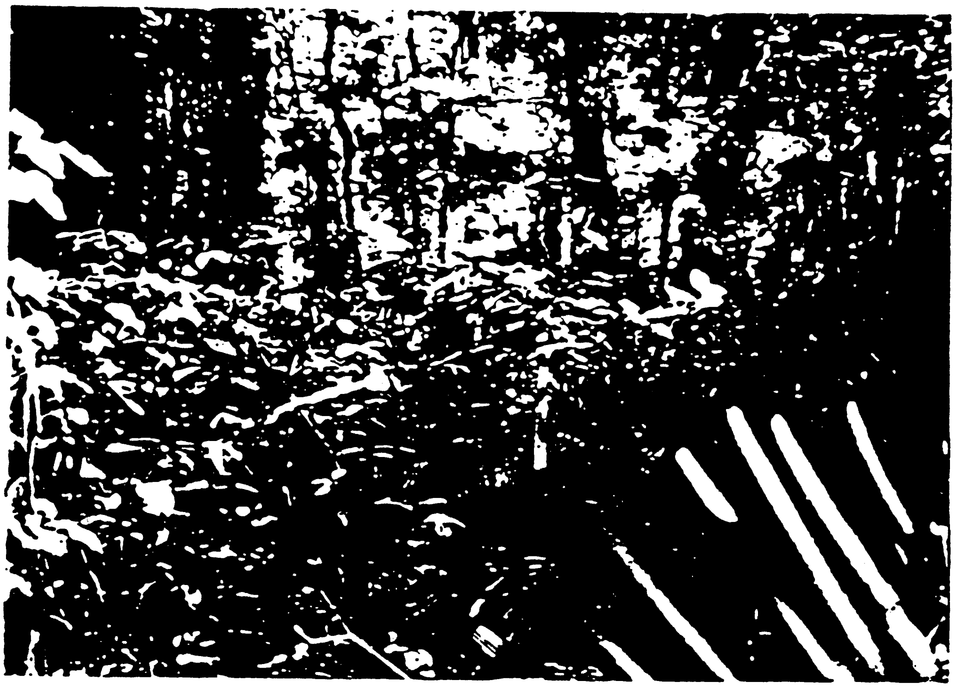
The average percent canopy closure was 95.4, which is generally indicative of a mature forest stand with a multi-layered canopy (Photograph 4). The lowest canopy closure recorded was 82 percent, which occurred at one of the sites located on private lands that was completely surrounded by croplands. Only seven colonies were located in stands with canopy closures of less than 94 percent (Figure 5).

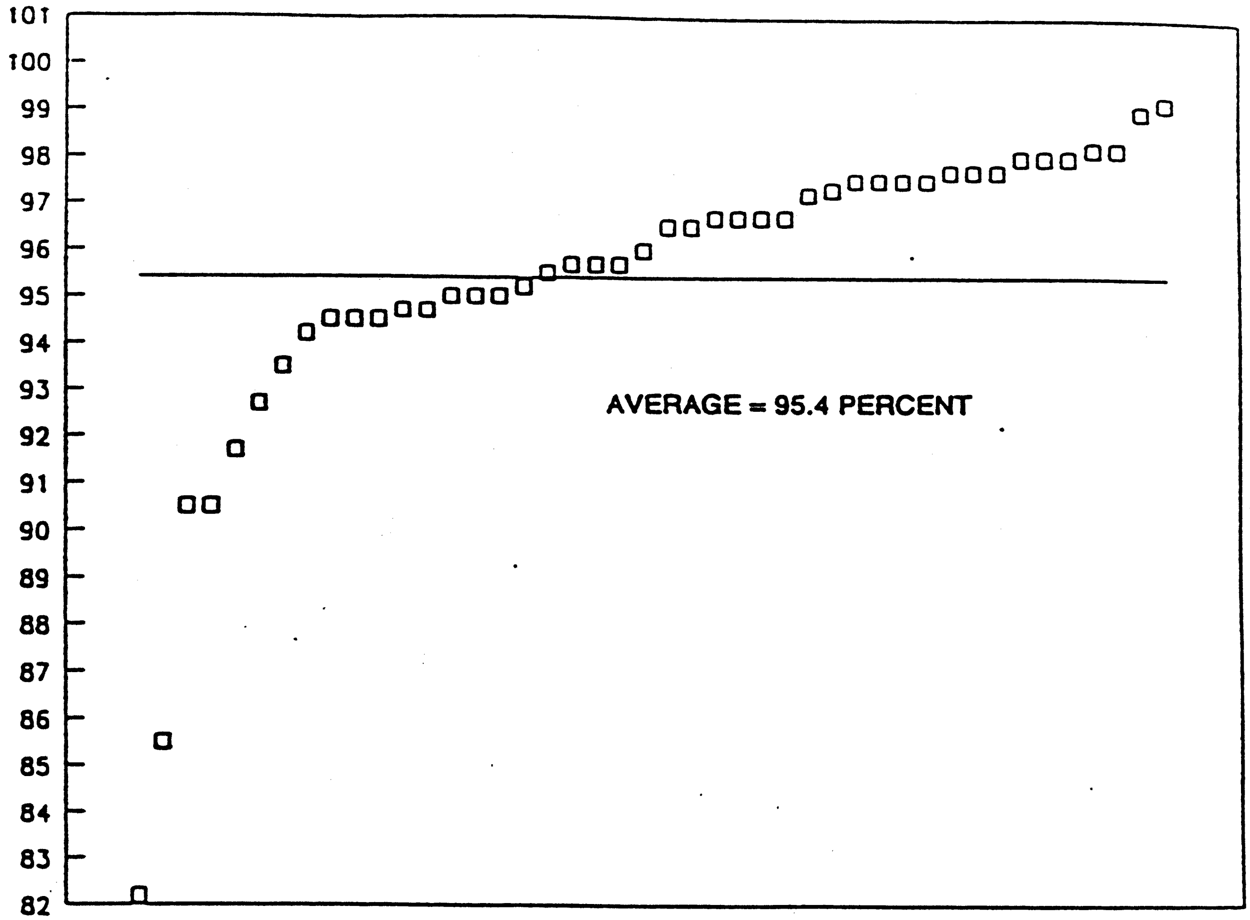
Oaks, primarily *Quercus lyrata*, *Q. phellos*, and *Q. nuttallii*, were the most frequently recorded overstory species occurring at 82 percent of the colony sites. Sweetgum (*Liquidambar styraciflua*) and elms (*Ulmus americana*, *U. alata*, and *U. crassifolia*) were recorded in the overstory of about 60 percent and 50 percent of the sites, respectively.

Sweetgum and sugarberry (*Celtis laevigata*) were the most common understory species, occurring in 70 and 57 percent of the sites, respectively. The most common shrub species were American snowbell (*Styrax americana*) and deciduous holly (*Ilex decidua*), both of which occurred in over 82 percent of the sites. Other common shrub species, in descending order of frequency, include: sugarberry, red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), elms, swamp dogwood (*Cornus drummondii*), oaks, palmetto (*Sabal minor*), elderberry (*Sambucus canadensis*), persimmon (*Diospyros virginiana*), red mulberry (*Morus rubra*), and sweetgum.

Oaks were recorded within either the overstory, understory, or shrub layer in all of the sites. The other species that were most frequently recorded in at least one of the vegetation layers included elm (98 percent), sugarberry (86 percent), green ash (84 percent), and sweetgum (82 percent). The strongest correlation between any two of the species occurring at a given site was with sweetgum and palmetto.

Photograph 4. Pondberry colony under dense BLH canopy.





Source: GMI

Figure 5. Average percent canopy cover.

IV. CONCLUSIONS AND RECOMMENDATIONS

This section discusses the conclusions, based upon the results of GMI's field investigations, of a typical pondberry colony in Mississippi. This profile was presented to and reviewed by several known pondberry experts during a workshop conducted at the Vicksburg District, as will also be discussed later in this section. Recommendations for subsequent investigations and potential mitigation measures are presented in the last part of this section.

PROFILE OF A TYPICAL PONDBERRY COLONY IN MISSISSIPPI

Based upon physical and biological data, it appears that the typical pondberry colony within Mississippi should occur on slight ridges in a ridge and swale community which is either frequently or periodically flooded (Photograph 5), or is in proximity (less than 100 feet) to a permanent waterbody, with soils that are comprised of silty clays, silty loams, or a combination of the two. The pondberry populations in Mississippi are shade tolerant and probably shade dependent. Common associate tree species are oaks, sweetgum, and elms, while common associate shrub species are American snowbell, deciduous holly and palmetto.

However, it should be noted that because the majority of the colonies are located on the Delta National Forest and the Forest Service manages for oaks, the apparent importance of oaks as associate species may be exaggerated. It should also be noted that, although cypress (_Taxodium_ _distichum_ and/or _T._ _ascendens_) has been reported from various locales as a common associate, the closest cypress tree to any of the pondberry sites visited was 50 feet and the majority of the sites (86 percent) were beyond 200 feet from the nearest cypress tree. Further, the cypress trees recorded within 200 feet of the pondberry colonies were usually individual or sporadically located trees that did not comprise a cypress community.

Photograph 5. Typical pondberry colony on relatively flat **terrain** with slight ridge and swales.

(Note the absence of ground cover in the foreground indicating long periods of standing water.)

Pondberry colonies in Mississippi are located at elevations above the 15-20 year floodplain of the Big Sunflower River. River stages of the Big Sunflower River at Holly Bluff, Mississippi, and the average elevation of pondberry colonies on the DNF (ie. 95 feet NGVD) indicate that the colonies in Mississippi are likely located above the 15-20 year floodplain of larger rivers.

PONDBERRY PROFILE WORKSHOP

On 19 December 1990, GMI, in conjunction with U.S. Army Corps of Engineers, Vicksburg District, conducted a workshop at the District's Office. The workshop's attendees consisted of U.S. Army Corps of Engineers personnel, GMI personnel, U.S. Forest Service representatives, USFWS representatives and various pondberry experts from universities, The Nature Conservancy, and state Natural Heritage programs. The basic objectives of the meeting were to critically review the pondberry profile developed by GMI, to identify potential impacts of proposed flood control projects on pondberry colonies that may occur within project area and to determine the feasibility of developing a stratified sampling scheme for future surveys and possible surveying approaches.

The workshop participants provided two main conclusions. First, local precipitation and hydrology have more of an influence on the pondberry colonies than overbank flooding, since the colonies on the Delta National Forest are located above the 15-20 year floodplain. The group also concluded that subsequent surveys should be limited to mature bottomland hardwood communities with a mixture of heavy clays and silty loam soils and that cypress/tupelo swamps, scrub/shrub communities, and natural levees and point bars could be eliminated from future surveys.

A copy of the workshop's minutes is presented in Appendix B. Also included in Appendix B is a copy of a letter submitted by the Vicksburg District to each attendee asking for their thorough review and comments of the minutes. No comments were received from any of the participants concerning the minutes.

RECOMMENDATIONS

Based upon the data gleaned from existing pondberry colonies and the workshop discussions, GMI suggests that subsequent surveys for pondberry can be limited to those areas which will be directly affected by construction, provided that the proposed project will not significantly alter local hydrology in areas where pondberry may occur. A buffer zone of at least 200 feet around construction areas should also be surveyed. If pondberry colonies are found within construction rights-of-way, mitigative measures such as realignment or transplanting would be necessary. In addition, pondberry colonies found within the 5-year floodplain of major streams may indicate a need to reevaluate habitat requirements and subsequent survey approaches.

Future field investigations, such as Habitat Evaluation Procedures (HEP) studies should, whenever practical, incorporate surveys for pondberry in order to locate unknown colonies that may aid in confirming/refuting current theories about the habitat requirements of pondberry.

APPENDIX A
ANNOTATED BIBLIOGRAPHY

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South: Vol. 1 Isoetaceae through Euphorbiaceae. USDA Forest Service. Tech. Publ. R8-TP2, pp 459-462.

Brief report that gives technical description of pondberry. Also relates distribution and flowering season, special identification features, habitats, associated species, etc.

Klomps, V. L. 1980. Status Report on _Lindera melissifolium_ (Walt.) Blume. Missouri Department of Conservation.

Sixteen page status report that discusses species information such as classification and nomenclature, present legal status at the time of the report, geographical distribution, environment and habitat, etc. This report gives assessments, recommendations, and information sources pertinent to pondberry.

Klomps, V. L. 1980. The Status of _Lindera melissifolium_ (Walt.) Blume, Pondberry, in Missouri. Trans. Missouri Acad. Sci. 14:61-66.

This publication discusses the historical and current status of pondberry, its morphological characteristics, habitat and associated species in Missouri, and indicates unknowns such as habitat requirements, reproduction, pollination, disease, and predation.

Mansburg, Laura. 1983. Letter (with attachments) to Gary Tucker, Arkansas Tech University, dated 27 October 1983. North Carolina Department of Natural Resources and Community Development. Raleigh, North Carolina.

This letter and attachments summarize locations of pondberry in North Carolina and some ecological characteristics eg., associate species. Included as attachments were field notes by Ms. Julie Moore.

Morris, N.W. 1987. Lindera melissifolia in Mississippi. Castanea 51:226.

This article gives a brief description of known colonies in Mississippi and reveals a new location 6 miles northeast of Cleveland, MS, in Sunflower County. The habitat associated with the location is given along with relevant colony size, health, and associated species.

Radford, A.E. 1976. Vegetation - Habitats - Floras, Natural Areas in the Southeastern United States: Field Data and Information. University of North Carolina Student Stores, University of North Carolina, Chapel Hill.

Field notes from bog-sink forest in Berkeley County, South Carolina approximately 2 miles northeast of Honey Hill. Gives information on slope, canopy height, topsoil depth, soil pH, depth of water table, and delineates trees, shrubs, herbs, and forbs found on the site associated with pondberry.

Steyermark, J.A. 1949. *Lindera melissaefolia*. Rhodora 51:153-162.

This article reveals history of *Lindera melissaefolia* and relates confusion/obscurity associated with *Lindera benzoin* var. *pubescens*. The author discusses records and history of both pondberry and spice bush and describes morphological, physiological and other differences.

Tucker, G.E. 1974. The Vascular Plant Family Lauraceae in Arkansas. Ark. Acad Sci. Proc. 28:74-75.

This publication discusses four species in Arkansas that represent the family Lauraceae. These four are of the genera *Lindera*, *Persea*, and *Sassafras*. Pondberry is reported in Arkansas for the first time with keys, distribution maps, and other relevant information given.

Tucker, G.E. 1984. Status Report on *Lindera melissifolia* (Walt.) Blume. Provided under contract to the U.S. Fish and Wildlife Service, Southeast Region, Atlanta, Georgia.

This lengthy report gives an overall review of biology, ecology, description, distribution, and other relevant facts known about pondberry at the time of publication. The status report gives assessments of vigor, trends, critical habitat and gives recommendations for conservation/recovery. Sources of information/literature previously published as well as new information is also presented.

U.S. Fish and Wildlife Service. 1986. Endangered and threatened wildlife and plants: determination of endangered status for *Lindera melissifolia*. Federal Register. 51:27495-27499.

Final ruling which justifies determination of pondberry as an endangered species. Gives background information on population status, critical habitat, available conservation measures and summaries of comments, recommendations, and factors affecting the species.

U.S. Fish and Wildlife Service. 1990. Pondberry Technical Draft Recovery Plan. Atlanta, Georgia 52pp.

This draft report first gives a general species description and detailed technical description of pondberry. The current range and status along with the life history, reproductive for decline. Most importantly, a draft recovery plan is presented detailing objectives and methods to utilize in achieving those objectives. The recovery plan is based upon apparent habitat requirements and current status of Missouri populations of pondberry.

Wofford, B.E. 1983. A New Lindera (Lauraceae) from North America. J. Arnold Arbor. 64:325-331.

This publication mainly describes a potential new species, Lindera subcoriacea. In addition, this article also relates typical habitats, morphological and physiological characteristics, associated species, and other facts relative to pondberry.

APPENDIX 2

MINUTES OF MEETING

17 November 1993
U.S. Army Corps of Engineers, Vicksburg District
Vicksburg, Mississippi

Big Sunflower Maintenance Project
Biological Assessment of Pondberry
Big Sunflower Supplemental Environmental Impact Statement
Contract No. DACW38-92-D-0018, Delivery Order No. 004
Geo-Marine Project No. 1118-004

Attendees:

Steve Reed	Vicksburg COE	Harvey Huffstatler	USFWS
Marvin Cannon	Vicksburg COE	Allan Mueller	USFWS
Jim Chandler	Vicksburg COE	Cary Norquist	USFWS
Larry Banks	Vicksburg COE	Chris Ingram	Geo-Marine
Gary Young	Vicksburg COE	Dwayne Templet	Geo-Marine
Kent Parrish	Vicksburg COE	Patrick Chubb	Geo-Marine
Frankie Griggs	Vicksburg COE		

The meeting was held at 1:30 p.m. at the Vicksburg District office to discuss the proposed Sunflower River maintenance project and the potential impacts on pondberry (*Lindera melissifolia*).

Steve Reed opened up the meeting by giving some background information on the proposed maintenance project. He then introduced Larry Banks, hydrologist with the Vicksburg District, to further discuss the history/background of the Big Sunflower River Basin and the hydrologic impacts of the proposed maintenance project.

Mr. Banks gave a thorough description of the flooding/hydrology history of the Sunflower River Basin. He also discussed the features of the proposed maintenance work and emphasized that the proposed maintenance project is designed to restore the channels within the basin to the 1962 post-project flow lines. The overall impact of the maintenance work would lower current flow lines within the channels 1 to 1.5 feet. This change in flow lines would only affect headwater floods; backwater floods will still occur at the same pre-maintenance frequency, duration, etc.

Mr. Banks then discussed the potential impacts of the maintenance project to pondberry. A summary of some backgroun information and Mr. Banks discussion is as follows:

> All areas of potential direct impacts such as rights-of-way and spoil disposal areas were 100% surveyed for pondberry by Geo-Marine, Inc.. One pondberry colony was found within 400-ft of the Big Sunflower River in a forested bend near Fifteen Mile Island. Project maintenance activities and the location of a spoil disposal area in the vicinity of

the colony will be altered to ensure that no adverse impacts to the pondberry colony will occur. Mr Banks also discussed the potential hydrologic (indirect) impacts to pondberry. He handed out graphs and figures to the attendees which presented/evaluated gage data for the Big Sunflower River at Holly Bluff, Mississippi for the period of 1950 - 1992 (Attachment A). The elevations that the District has on 13 pondberry colonies located in the northern portion of Delta National Forest (DNF) range from 94.5 - 98 feet NGVD with an average elevation of 96.7 feet. This area in the northern portion of the DNF corresponds with Holly Bluff gage data. According to this data, the group concluded that the colony at the lowest elevation is inundated by overbank flooding once every 6 - 7 years and the colony at the highest elevation is subject to overbank flooding once every 43 years. On average, the 13 pondberry colonies are subject to overbank flooding once every 20 years. The proposed maintenance project would improve flooding conditions more in areas north of DNF. In the DNF area, the hydrologic impact would be a 2-3 day reduction in headwater flood duration; headwater flooding frequency in the overbank areas of the DNF area and project area south of Holly Bluff will not experience any significant reduction from pre-maintenance conditions.

The meeting then evolved to an open discussion about pondberry and the potential impacts of the proposed maintenance project. The District's position, backed by the hydrologic data presented by Mr. Banks, was that pondberry colonies on the DNF are influenced by local hydrology and would not be impacted by changes in overbank flooding due to the maintenance project. Representatives of the USFWS contended that the current condition and location of pondberry colonies within the DNF do not necessarily represent ideal situations; the pondberry colonies have survived changes in the historic hydrology of the Delta but may not be thriving, in fact, they may be stressed. Mrs. Norquist was concerned about colonies in the southern part of DNF as well colonies discovered since 1991 which may be located at lower elevations that the 13 colonies evaluated by the District.

Mr. Mueller outlined the concerns of the USFWS by indicating three major issues to be resolved in the biological assessment:

1. Determine the acres within the DNF that have been surveyed for pondberry by the U.S. Forest Service.
2. Determine the locations of pondberry colonies recently discovered on the DNF (colonies found since 1991).
3. Determine if any known or recently discovered pondberry colonies are located at elevations lower that the original 13 colonies evaluated by the District. If the elevations are the same, then the proposed maintenance work would not pose a threat to pondberry.

Mr. Huffstatler and Mrs. Norquist concurred with Mr. Mueller's summary. Representatives of the District thanked the assembled group for attending the meeting. The assembled group then concluded discussions and the meeting was adjourned.

ATTACHMENT A

Big Sunflower at Holly Bluff, Miss.
Gage Zero= 0.58 Feet NGVD

Year	High Stage	High Date	Low Stage	Low Date
1950	95.53	Mar 4	66.52	Nov 2
1951	92.13	Mar 31	66.03	Oct 25-30
1952	89.64	Apr 16-17	65.51	Nov 4-9
1953	90.72	May 22	65.48	Nov 18-19
1954	85.40	May 14	64.81	Aug 21
1955	92.15	Apr 15-16	64.86	Nov 12
1956	90.13	Feb 21	64.64	Aug 20
1957	90.16	Dec 2	66.44	Sep 2
1958	93.12	May 23-24	67.46	Dec 31
1959	90.21	Feb 18	65.88	Nov 26
1960	88.71	Mar 5	65.39	Nov 8
1961	93.79	Apr 13	65.53	Oct 29
1962	93.20	Apr 17-18	65.73	Dec 13
1963	86.20	Apr 8	65.10	Nov 27
1964	93.57	May 2	66.07	Nov 21-22
1965	92.87	Feb 17	65.45	Nov 5 Dec 3-4
1966	93.82	Feb 18	64.95	Dec 8
1967	88.03	Dec 20	65.14	Nov 21-22
1968	94.17	Jan 15	65.70	Nov 15
1969	91.23	Apr 20	65.27	Nov 10
1970	92.44	Apr 29	68.28	Oct 11
1971	92.51	Mar 2	65.52	Nov 12-14
1972	93.46	Jan 11	65.58	Oct 21
1973	100.94	May 16-19	66.89	Oct 5
1974	95.49	Feb 3	66.82	Oct 28
1975	96.97	Apr 16	66.33	Oct 14
1976	89.86	Mar 11	65.16	Nov 20
1977	90.28	Mar 8	65.50	Feb 23
1978	92.06	May 14	67.16	Feb 27
1979	96.40	May 5	69.30	Nov 8
1980	93.30	Apr 18	66.80	Sep 25
1981	83.40	Feb 3	67.10	May 16
1982	94.60	Dec 29	67.60	Nov 8
1983	95.40	Jun 7	68.30	Oct 21
1984	91.90	May 15	67.50	Oct 5
1985	89.30	Dec 15	67.20	Sep 4
1986	90.00	Nov 27	66.30	Feb 8
1987	91.00	Mar 20	65.80	Sep 24
1988	89.20	Jan 2	65.80	Oct 12
1989	91.60	Mar 2	68.00	Dec 26
1990	91.80	Feb 16	68.30	Oct 7
1991	95.99	May 19	75.28	Jun 20
1992	84.11	Feb 16	66.89	Apr 18

Little Sunflower Control Structure Intake
Gage Zero= 0.00 Feet NGVD

	High		Low	
Year	Stage	Date	Stage	Date
1979	97.40	April 28	68.80	Sep 20
1980	91.50	Apr 14	62.5	Nov 2
1981	80.70	Jun 15	65.50	Sep 3
1982	91.20	Dec 31	60.50	Aug 12
1983	95.80	May 31	68.30	Nov 19
1984	91.90	May 23	64.60	Aug 28
1985	87.60	Dec 16	67.10	Sep 3
1986	82.90	Dec 18	65.60	Jun 30
1987	86.30	Mar 21	64.90	Sep 25
1988	85.90	Jan 8	64.80	Oct 11
1989	90.00	Mar 9	68.60	Dec 28
1990	89.90	Mar 3	68.30	Aug 12
1991	93.80	May 9	68.10	Nov 12

Yazoo River at Mouth Big Sunflower
Gage Zero= 0.00 Feet NGVD

Year	High Stage	High Date	Low Stage	Low Date
1962	93.40	Apr 19	58.10	Dec 12,20-22
1963	86.70	Apr 7-8	58.10	Nov 25
1964	91.65	May 5-7	59.20	Sep 27
1965	89.90	Feb 17-19	57.45	Dec 11-12
1966	91.25	Feb 19-21	57.90	Dec 8
1967	86.70	May 25	58.55	Jan 28
1968	91.85	Apr 14-16	62.20	Nov 16
1969	90.40	Feb 22 Apr 21	60.00	Nov 15-16
1970	91.30	May 6	67.10	Sep 26
1971	90.95	Mar 6	60.70	Nov 27
1972	91.00	Jan 8-12	62.10	Jun 13-15
1973	101.54	May 15-18	67.20	Oct 4
1974	95.90	Feb 16	70.60	Aug 12-13
1975	97.60	Apr 16-17	67.60	Oct 25
1976	89.30	Mar 17	60.00	Dec 5-7
1977	87.00	Mar 15	58.00	Aug 19
1978	89.30	May 13-14	64.60	Oct 16-18
1979	77.70	Apr 26-29	70.70	Nov 9
1980	94.40	Apr 16-17	60.00	Dec 31
1981	81.70	Jun 14	59.60	Jan 1
1982	93.80	Dec 29	60.50	Jan 1
1983	99.50	May 28-31	69.80	Oct 29
1984	95.00	May 25	63.00	Oct 6
1985	91.70	Mar 16	61.40	Jul 23
1986	86.10	Nov 26	61.90	Aug 12
1987	90.60	Mar 19-20	59.80	Aug 13
1988	87.30	Jan 7	61.00	Jul 17
1989	93.80	Mar 8	69.10	Oct 18
1990	93.60	Mar 6	65.10	Oct 9
1991	96.40	May 10	69.70	Nov 19
1992	84.11	Feb 16	66.89	Apr 18

BIG SUNFLOWER RIVER MAINTENANCE PROJECT
BIOLOGICAL ASSESSMENT
LOUISIANA BLACK BEAR

RECOMMENDED PLAN STUDIED IN DETAIL

1. The recommended plan for the Big Sunflower River Maintenance Project consists of 104.8 miles of channel cleanout and 28.3 miles of channel clearing and snagging in the Sunflower River Basin of the State of Mississippi. This maintenance project will focus only on the lower 75.6 miles of the Big Sunflower River, the lower 24.2 miles of Bogue Phalia, the lower 8.0 miles of Dowling Bayou, and all of the Little Sunflower River, Big Sunflower Bendway, and Bogue Phalia Cutoff. Table 1 shows a summary of the recommended work.

2. The maintenance measures for the Big Sunflower main stem consist of 58.2 miles (49.4 miles of 3-foot cleanout and 9.2 miles of channel restoration to authorized width and grade) of channel cleanout. No work is required on 10.1 miles; channel conveyance is sufficient in these reaches because of the existing large cross-sectional area to convey the design flow below the design flow line. No work is also designated for 0.4 mile to avoid high densities of mussels. All work, except for the channel restoration from mile 19.2 to mile 26.1 (Holly Bluff Cutoff) which is recommended to be done by dragline, is recommended to be done by hydraulic dredge.

3. Recommended maintenance on Little Sunflower consists of 13.5 miles of channel cleanout (removal of 3 to 4 feet of material) and 7.2 miles of channel clearing and snagging. No work is required below mile 7.0 since there is sufficient existing channel capacity in this reach to convey design flows. Channel cleanout is recommended to be accomplished by hydraulic dredge and the channel clearing and snagging by dragline.

4. Necessary maintenance measures on the Big Sunflower Bend consist of 14.3 miles of channel cleanout (removal of 3 feet of material). This work is recommended to be done by hydraulic dredge.

5. The maintenance measures on the Bogue Phalia consist of 18.8 miles (6.1 miles of channel cleanout and 12.7 miles of channel restoration to authorized bottom width and grade) of channel cleanout and 4.4 miles of channel clearing and snagging. All work is recommended to be done by dragline.

6. Recommended maintenance on Bogue Phalia Cutoff consists of 12.4 miles of channel clearing and snagging. Work is recommended to be done by dragline.

7. Maintenance measures on Dowling Bayou consist of 4.3 miles of channel clearing and snagging from mile 3.7 to mile 8.0. Work is recommended to be done by dragline.

TABLE 1
BIG SUNFLOWER MAINTENANCE

Stream	Mileage (Improved)	Type of Improvement
Big Sunflower River	6.9 - 19.2	Channel Cleanout - 3 ft - 85 ft width
	19.2 - 26.1	Channel Cleanout - 80 ft bottom a/
	26.1 - 26.4	Channel Cleanout - 200 ft bottom a/
	26.4 - 26.6	No Work b/
	26.6 - 28.4	Channel Cleanout - 200 ft bottom
	28.4 - 37.9	No Work
	37.9 - 49.6	Channel Cleanout - 3 ft - 250 ft width
	49.6 - 50.2	No Work
	50.2 - 53.9	Channel Cleanout - 3 ft - 250 ft width
	53.9 - 54.1	No Work c/
	54.1 - 57.5	Channel Cleanout - 3 ft - 250 ft width
	57.5 - 70.6	Channel Cleanout - 3 ft - 250 ft width
	70.6 - 75.6	Channel Cleanout - 3 ft - 150 ft width
Little Sunflower River	7.0 - 11.5	Channel Cleanout - 4 ft - 125 ft width
	11.5 - 15.0	Channel Cleanout - 3 ft - 125 ft width
	15.0 - 20.5	Channel Cleanout - 3 ft - 100 ft width
	20.5 - 27.7	Channel Clearing - 150 ft. width
Big Sunflower River Bendway	19.2 - 28.3	Channel Cleanout - 3 ft - 125 ft width
	28.3 - 33.5	Channel Cleanout - 3 ft - 125 ft width
Bogue Phalia	1.0 - 7.1	Channel Cleanout - 60 ft bottom
	7.1 - 19.8	Channel Cleanout - 75 ft bottom a/
	19.8 - 24.2	Channel Clearing - 275 ft width
Bogue Phalia Cutoff	0.0 - 12.4	Channel Clearing - 125 ft width
Dowling Bayou	0.0 - 3.7	No Work
	3.7 - 8.0	Channel Clearing - 65 ft width

a/ Restoration of channel to authorized bottom width and grade.
b/ No work reach to avoid high density mussel bed.
c/ Lock and Dam No. 1 (abandoned) and high density mussel bed.

8. Mitigation measures have been included in the plan to compensate for adverse effects to fish and wildlife resources and wetlands.

REVIEW OF LITERATURE AND PERTINENT SCIENTIFIC DATA

9. The U.S. Fish and Wildlife Service has determined the Louisiana black bear (Ursus americanus luteolus) to be a threatened species within its historic range. The historic range of the Louisiana black bear includes southern Mississippi, Louisiana, and east Texas. The U.S. Fish and Wildlife Service also designated other free living bears of the species Ursus americanus within the Louisiana black bear's historic range as threatened due to similarity of appearance and the authority of the Endangered Species Act of 1973.

10. Based on information collected by the Mississippi Department of Wildlife, Fisheries and Parks, it is estimated there are now 25 to 50 bears scattered statewide in the Mississippi, Pearl, and Pascagoula River drainages. The present range of the black bear in Mississippi includes portions of the Delta National Forest, Eagle Lake, and surrounding lands (Pelton).

11. Since the turn of the century, bear habitat has been significantly altered or eliminated throughout much of the tri-state region of Mississippi, Louisiana, and east Texas. This significant reduction in bear habitat and illegal kill that have taken place resulted in a decline to an estimated population of less than 300 individuals.

12. Black bears are primarily animals of heavily wooded areas. Preliminary estimates of home range size indicate adult males may utilize from 1,500 to 40,000 acres. These acreages include combinations of forested and open lands.

13. Monitoring of radio-collared bears and observation of bear sign document that uncleared drains, ditches, bayous, and riverbanks are sometimes used to traverse open land when bears move from one forested tract to another. Data indicate travel corridors may be important to the movements of adult bears and the dispersal of juveniles through agricultural lands. Drainage ditches lined with trees and brush, even as narrow as 50 yards wide, have been used by bears to pass through open agricultural areas. Based on comparative data, this may be the minimum width for a viable corridor.

14. Bears are omnivorous feeders. They will occasionally eat meat or animal matter, such as mice and squirrels; however, they are perhaps as much as 95 percent vegetarians. Oak mast, field corn, muscadines, and blackberries are consumed in large quantities, as is honey when available. Depredations on livestock are negligible; however, bears often do serious damage to corn crops and beehives.

LIKELY IMPACTS TO THE BLACK BEAR

15. The recommended plan will have some impacts to lands that could be used by the bear. Implementation of the plan will result in the conversion of 1,406 acres of agricultural lands and 443 acres of bottom-land hardwoods to

dredged material sites. In addition, 1,912 acres of seasonally flooded agricultural lands will be reforested with selected bottom-land species as mitigation. The loss of agricultural lands probably would not have an impact on corn acreage that could be utilized by the bears since only a small percentage of corn acreage exists in the 715,594-acre study area. There are approximately 175,075 acres of bottom-land hardwoods located in the lower portion of the study area in or near the Delta National Forest. The short-term loss of only 443 acres of these woodlands should not constitute an adverse impact to any bears in the study area. Implementation of the recommended plan should not have any adverse impacts to the black bear or bear habitat.

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BIG SUNFLOWER RIVER MAINTENANCE PROJECT
BIOLOGICAL ASSESSMENT
PALLID STURGEON

1. The recommended plan for the Big Sunflower River Maintenance Project consists of 104.8 miles of channel cleanout and 28.3 miles of channel clearing and snagging in the Sunflower River Basin of the State of Mississippi. This maintenance project will focus only on the lower 75.6 miles of the Big Sunflower River, the lower 24.2 miles of Bogue Phalia, the lower 8.0 miles of Dowling Bayou, and all of the Little Sunflower River, Big Sunflower Bendway, and Bogue Phalia Cutoff. Table 1 shows a summary of the recommended work.

2. The maintenance measures for the Big Sunflower main stem consist of 58.2 miles (49.4 miles of 3-foot cleanout and 9.2 miles of channel restoration to authorized width and grade) of channel cleanout. No work is required on 10.1 miles; channel conveyance is sufficient in these reaches because of the existing large cross-sectional area to convey the design flow below the design flow line. No work is also designated for 0.4 mile to avoid high densities of mussels. All work, except for the channel restoration from mile 19.2 to mile 26.1 (Holly Bluff Cutoff) which is recommended to be done by dragline, is recommended to be done by hydraulic dredge.

3. Recommended maintenance on Little Sunflower consists of 13.5 miles of channel cleanout (removal of 3 to 4 feet of material) and 7.2 miles of channel clearing and snagging. No work is required below mile 7.0 since there is sufficient existing channel capacity in this reach to convey design flows. Channel cleanout is recommended to be accomplished by hydraulic dredge and the channel clearing and snagging by dragline.

4. Necessary maintenance measures on the Big Sunflower Bend consist of 14.3 miles of channel cleanout (removal of 3 feet of material). This work is recommended to be done by hydraulic dredge.

5. The maintenance measures on the Bogue Phalia consist of 18.8 miles (6.1 miles of channel cleanout and 12.7 miles of channel restoration to authorized bottom width and grade) of channel cleanout and 4.4 miles of channel clearing and snagging. All work is recommended to be done by dragline.

6. Recommended maintenance on Bogue Phalia Cutoff consists of 12.4 miles of channel clearing and snagging. Work is recommended to be done by dragline.

7. Maintenance measures on Dowling Bayou consist of 4.3 miles of channel clearing and snagging from mile 3.7 to mile 8.0. Work is recommended to be done by dragline.

PALLID STURGEON (Scaphirhynchus albus)
REVIEW OF LITERATURE AND PERTINENT SCIENTIFIC DATA

8. The pallid sturgeon is one of the largest fish found in the Missouri, middle and lower Mississippi, Platte, Kansas, and Yellowstone Rivers.

TABLE 1
BIG SUNFLOWER MAINTENANCE

Stream	Mileage Improved	Type of Improvement
Big Sunflower River	6.9 - 19.2	Channel Cleanout - 3 ft - 85 ft width
	19.2 - 26.1	Channel Cleanout - 80 ft bottom a/
	26.1 - 26.4	Channel Cleanout - 200 ft bottom a/
	26.4 - 26.6	No Work b/
	26.6 - 28.4	Channel Cleanout - 200 ft bottom
	28.4 - 37.9	No Work
	37.9 - 49.6	Channel Cleanout - 3 ft - 250 ft width
	49.6 - 50.2	No Work
	50.2 - 53.9	Channel Cleanout - 3 ft - 250 ft width
	53.9 - 54.1	No Work c/
	54.1 - 57.5	Channel Cleanout - 3 ft - 250 ft width
	57.5 - 70.6	Channel Cleanout - 3 ft - 250 ft width
	70.6 - 75.6	Channel Cleanout - 3 ft - 150 ft width
Little Sunflower River	7.0 - 11.5	Channel Cleanout - 4 ft - 125 ft width
	11.5 - 15.0	Channel Cleanout - 3 ft - 125 ft width
	15.0 - 20.5	Channel Cleanout - 3 ft - 100 ft width
	20.5 - 27.7	Channel Clearing - 150 ft. width
Big Sunflower River Bendway	19.2 - 28.3	Channel Cleanout - 3 ft - 125 ft width
	28.3 - 33.5	Channel Cleanout - 3 ft - 125 ft width
Bogue Phalia	1.0 - 7.1	Channel Cleanout - 60 ft bottom
	7.1 - 19.8	Channel Cleanout - 75 ft bottom a/
	19.8 - 24.2	Channel Clearing - 275 ft width
Bogue Phalia Cutoff	0.0 - 12.4	Channel Clearing - 125 ft width
Dowling Bayou	0.0 - 3.7	No Work
	3.7 - 8.0	Channel Clearing - 65 ft width

a/ Restoration of channel to authorized bottom width and grade.
b/ No work reach to avoid high density mussel bed.
c/ Lock and Dam No. 1 (abandoned) and high density mussel bed.

Sightings have also occasionally come from near the mouths of such large tributaries to the Mississippi River as the Big Sunflower and St. Francis Rivers; however, these are rare and may be due to the fish utilizing unusual flow conditions.

9. The pallid sturgeon is apparently rare throughout its entire range. The species was listed as endangered by the U.S. Fish and Wildlife Service on 6 September 1991. The U.S. Fish and Wildlife Service finds that designation of critical habitat for the species is not presently determinable or prudent.

10. The species has experienced a dramatic decline throughout its approximately 3,550-mile range over the past 20 years. Almost all of the pallid sturgeon's habitat has been modified through river channelization, construction of impoundments, and related changes in flow regimes. These changes have blocked the pallid sturgeon's movements, destroyed or altered its spawning areas, reduced its food sources or its ability to feed, and altered water temperatures and other environmental conditions necessary for the fish's survival. Commercial fishing also has probably played a role in the decline. Another threat to the specie's survival is an apparent lack of reproduction. Potential threats include water pollution, interbasin transfer of water, hybridization of the species with the more abundant shovelnose sturgeon, and continuing alteration of remaining spawning or nursery areas.

11. There is only one documented pallid sturgeon catch in the lower Big Sunflower River. The specimen was caught on 23 November 1987 in the Big Sunflower River, 12 miles northwest of Satartia, Mississippi.

12. The pallid sturgeon requires large, turbid, free-flowing riverine habitat with rocky or sandy substrate. They are usually found near the bottoms of streams or lakes in sand flats or gravel bars. Some investigators report that the sturgeon appears to favor portions of streams where strong currents in or near the main channel occur.

13. The pallid sturgeon is an opportunistic feeder that feeds on aquatic insects, crustaceans, mollusks, annelids, eggs of other fish, and fish. The pallid sturgeon is noted as having a high incidence of fish in its diet.

14. Recent life history information on the pallid sturgeon indicates that increased water flows such as the June rise on the Missouri and Mississippi Rivers seems to trigger spawning. During spawning, which occurs from June to July, sturgeons release small batches of eggs over a 10- to 12-hour period. Once released, these sturgeon eggs do not hatch for 5 to 8 days. Any problems during this period, such as stilled waters or a moving bed load, would affect these eggs. The sturgeon generally spawns over hard, gravel beds found in the main tributaries or in or around the river channels.

15. The range of water depths where the pallid sturgeon was frequently found in South Dakota is 2 to 6 meters. In Montana, pallid sturgeon selected depths

which ranged from 1.2 to 3.7 meters in the summer, but selected deeper waters during winter. During late summer in North Dakota, the pallid sturgeon was captured at depths which range from 2.1 to 7.6 meters.

16. There is no information to indicate temperature preferences or the effects of temperature on the species.

17. The pallid sturgeon is considered a fine eating fish, and the roe is suitable for caviar. Its large size makes it a desirable trophy sport fish. Eleven states within the pallid sturgeon's range have some regulations which prohibit taking of the fish. However, some harvest problems still exist on the lower Mississippi River.

LIKELY IMPACTS TO THE PALLID STURGEON

18. The pallid sturgeon is probably only occasionally present near the mouth of the Big Sunflower River where some channel excavation would be performed. This excavation would be performed by a hydraulic dredge from river mile 6.9 to river mile 19.3. Confined receiving sites would be utilized to contain the dredged material from the channel.

19. The main channel of 12.4 miles of the lower Big Sunflower River would be dredged; however, this action should not result in any mortality to the pallid sturgeon since they would avoid the dredge. The turbidity plumes from the dredging activities should not have any adverse effects on the species since it inhabits large, muddy tributaries.

20. The dredge would remove some benthos that could be used for food to a minor extent; however, the sturgeon is largely a fish-eating species and would only occasionally be present in low numbers. Considering the information above, the impacts to benthos should not have any adverse effects on the sturgeon.

21. Suitable spawning substrate for this species is not present in the mouth of the Big Sunflower River. Hence, the species is not expected to spawn in the project area.

22. Overall, the project should not have any adverse effects on the pallid sturgeon.

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VICKSBURG DISTRICT
CORPSOFENGINEERS

AUGUST2001

REVISED FINAL REPORT

SURVEY REPORT
RE-EVALUATION OF PONDBERRY
INMISSISSIPPI

ContractNumber DACW38-00-F-0087

GULF SOUTH
RESEARCH
CORPORATION

Revised Final

Survey Report
Re-evaluation of Pondberry
in Mississippi

Prepared for:

U.S. Army Corps of Engineers, Vicksburg District
Planning, Programs, and Project Management Division
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August 24, 2001

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1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE), Vicksburg District, is currently investigating potential flood control alternatives in the Yazoo Backwater Area. Since there are known pondberry (*Lindera melissifolia*) locations in the project vicinity, the Vicksburg District needed to investigate the potential for the proposed project to affect extant pondberry communities.

Pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended, Federal agencies are obligated to insure that actions authorized, funded, or carried out are not likely to jeopardize the continued existence of any endangered species or result in adverse modification of critical habitat as determined by the U.S. Fish and Wildlife Service (USFWS). This report is generated as partial compliance with Section 7 of the ESA for the endangered pondberry.

The purpose of this study is to evaluate and update the existing pondberry profile relative to data gleaned from recently discovered colonies. Additional locations that have been discovered since the Vicksburg District performed previous pondberry surveys in the early 1990's were surveyed to characterize the new pondberry colonies.

The study area for this project includes the Delta National Forest (DNF) in Sharkey County, Mississippi, several parcels of private land located in Bolivar County, and a 32-acre plot located south of the DNF (Figure 1). Pondberry sites were surveyed between May 11 and June 20, 2000.

Figure 1: Project Study Area

gsrc / GULF SOUTH RESEARCH CORPORATION

SCALE: NOT TO SCALE

DATE: AUGUST 2001

2.0 BIOLOGICAL PROFILE

Pondberry is a low growing, deciduous shrub ranging in height from 1.0 to 6.5 feet (ft) that occurs in seasonally flooded wetlands, on the wet edges of sinks, ponds, and depressions. Pondberry has been affected by habitat destruction and alteration, disease and predation, poor reproductive success, drainage or flooding of wetlands, and extreme weather conditions (USACE 1996). At present, there are at least 38 populations known to exist in Arkansas, Georgia, Mississippi, Missouri, and North and South Carolina; it has most likely been extirpated from Alabama and Louisiana (UFSWS 1993). The species was officially listed as endangered by the USFWS in 1986 under the ESA (USFWS 1986).

Pondberry plants are stoloniferous and grow in clones of stems, usually unbranched. The species is dioecious and the flowers of both sexes are small and pale yellow. The mature fruit is a red drupe about 0.39 in long that matures in late summer or fall. Few details are known about the reproductive biology of pondberry. Due to the similarity between the flowers of pondberry and spicebush (*Lindera benzoin*), it is suspected that pondberry is insect pollinated (USACE 1996). Many populations consist predominantly of male plants. A mature colony often consists of a mixture of live and dead stems (USFWS 1993) with some evidence of dieback. Dieback is defined as the death of the tips of live stems. Devall *et al*. (nd) suggested that since dieback was present in all populations examined and that it has persisted for the last 20 years in the Missouri population, it was not a limiting factor in pondberry growth.

A profile was completed by the USACE in 1991 which determined that pondberry within Mississippi should occur on slight ridges, is frequently or periodically flooded, or is within 100 ft of a permanent waterbody, and is typically located on soils with a mixture of heavy clays and lighter soils. This study determined that common associate tree species were oaks, sweetgum, and elms and common associate shrub species were American snowbell, deciduous holly, and palmetto. The report also indicated that local precipitation and hydrology influence pondberry more than overbank flooding.

3.0 METHODS

Data were collected from existing pondberry colonies within the DNF, on private lands in Bolivar County, Mississippi, and a 32-acre plot south of the DNF. The team also surveyed portions of the Dahomey National Wildlife Refuge in northern Mississippi. A team of five people including an ecologist, three biologists, and one field technician performed the data collection. Compartment maps supplied by the Forest Service delineating known pondberry colonies in DNF were used to facilitate colony location in the field (USFS 2000). Each colony was given a unique colony ID number and recorded using GPS. The team collected numerous physical and biological data at each site (Appendix A).

Soil samples were collected at each site and classified according to Munsell Soil Color Charts (2000) for physical attributes (silt, loam, clay, etc.).

Elevations and distances were subsequently measured by a team of surveyors, led by a registered land surveyor (Pyburn and Odom, Inc. 2000).

Canopy cover was measured with a densiometer near the center of each pondberry colony. Ocular estimates for herbaceous cover was made by each member of the field team to develop a consensus. Associated species were recorded within a 0.1 acre plot surrounding the colony at each vegetational layer (i.e., overstory, understory, shrubs, and herbaceous cover). Diameter of overstory species within the 0.1 acre plot were measured using a diameter breast height (DBH) tape.

With the exception of the very large colonies, individual stems of each pondberry colony were counted and recorded. Stems were considered an individual plant if there was no connection to other stems at or near the ground. For large colonies, such as the ones found in Compartment 16 and at Shelby, Mississippi, the density of stems was found by sub-sampling five randomly selected one-meter plots within the colony. However, each female stem was counted and recorded, regardless of the size of the colony. Female stems were identified by the presence of maturing fruit.

The general health of the colony was a subjective value reached by the consensus of the team based upon the ratio of dying stems to live stems, physical appearance of the stem and leaves, and overall density of the colony. The presence of insect damage, fungal damage, or dieback was also noted.

Health of the colony was then quantified using density per square feet (ft^2), which was calculated by dividing the number of stems in the colony by the total area of the colony.

Field data were compiled into a database and pertinent quantitative field data were statistically analyzed using Microsoft Excel? software program. The analyses performed included means, standard deviations, ranges, and correlation coefficients.

4.0 RESULTS

4.1 General Data

A total of 62 pondberry colonies were surveyed, 12 of which were not located in the Delta National Forest (Figures 2-4). Appendix B presents data collected from all pondberry sites surveyed. Within the DNF, pondberry sites were relocated in compartments 1-4, 7, 14, 16, 25, 28, 30, 38-39, and 47. The 12 colonies not located in DNF were on private lands that supported small (less than five acres) bottomland hardwood communities surrounded by croplands, primarily cotton, soybeans, and rice. The field team was unsuccessful in relocating three colonies due to a recent salvage cut within the area, as well as the difficulty in identifying small pondberry colonies during the time of year when similar sized and shaped herbaceous species are thriving. No pondberry colonies were found on the Dahomey National Wildlife Refuge, although extensive colonies of a closely related species, spicebush (*Lindera benzoin*), were located. Additionally, no pondberry colonies were found on the 32-acre plot south of the DNF, which is the proposed Yazoo River Backwater pumping plant site.

Statistical analyses were performed on various data collected during the field surveys using regression analysis. A correlation coefficient is a number between –1 and +1 that describes the relationship between values and is expressed as an r value. The sign of the r indicates the type of relationship, whether positive or negative and the value of r without regard to sign indicates the strength of the linear relationship. The more closely a value of r approaches 1 (+/-), the stronger the relationship. Conversely, the more closely the value of r approaches 0, the weaker the relationship. The square of the correlation coefficient, r^2, indicates the proportion of total variance in one variable that is predictable; in other words, it is a direct measure of the strength of a relationship.

4.2 Physical Data

The approximate size of the pondberry colonies, as calculated by the surveyors, ranged from 21 ft^2 to 9000 ft^2 with an average of 1988 ft^2. All but four colonies (93%) were found in areas of localized depressions.

The average distance of a colony from a standing body of water, as measured by the surveyors, was approximately 64 ft. Of the 50 colonies in the DNF, the average distance of a colony from a waterbody was 80 ft. Only the colonies found at Shelby and Merigold were found in areas inundated with water, or areas of recent inundation. None of the colonies surveyed at DNF were found in standing water; however, approximately half of the colonies surveyed were in areas that could potentially hold water.

According to the Natural Resources Conservation Service (NRCS), the two dominant soil associations found in the DNF are the Sharkey-Alligator-Dowling and the Forestdale-Dundee-Dowling Associations (NRCS 1962). The Sharkey-Alligator-Dowling Assocation consists of poorly drained, clayey soils in slack-water areas. This association is found in areas where the slope is generally less than two percent, but may be as much as five percent along streambanks and depressions. The Forestdale-Dundee-Dowling Association consists of poorly drained soils that formed in moderately fine textured alluvium from the Mississippi River and its tributaries. The soils found at the colony sites were classified as clay loams or silty clay.

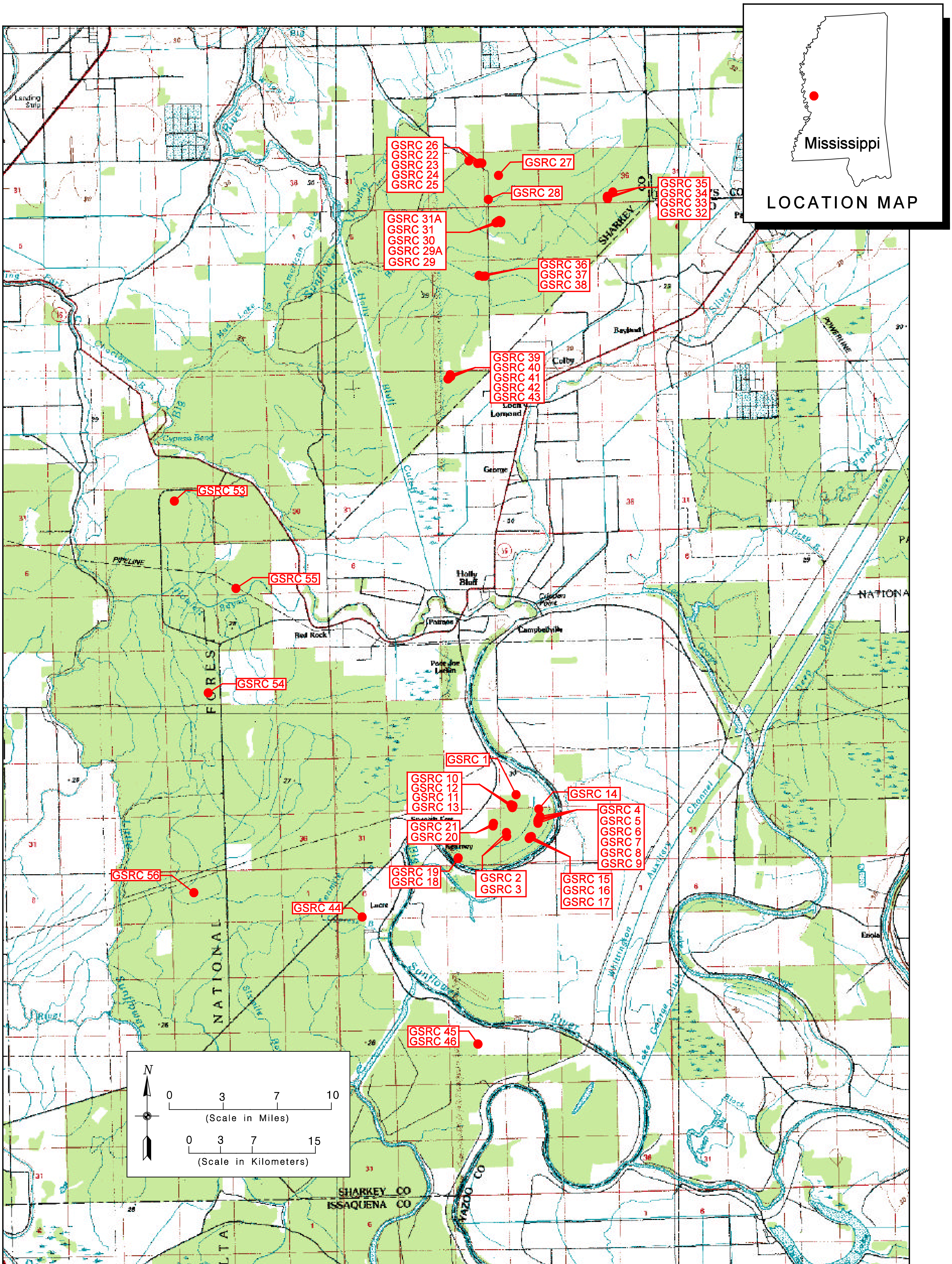

Figure 2: Pondberry Site Locations in Delta National Forest

Scale: on map

Date: August 2001

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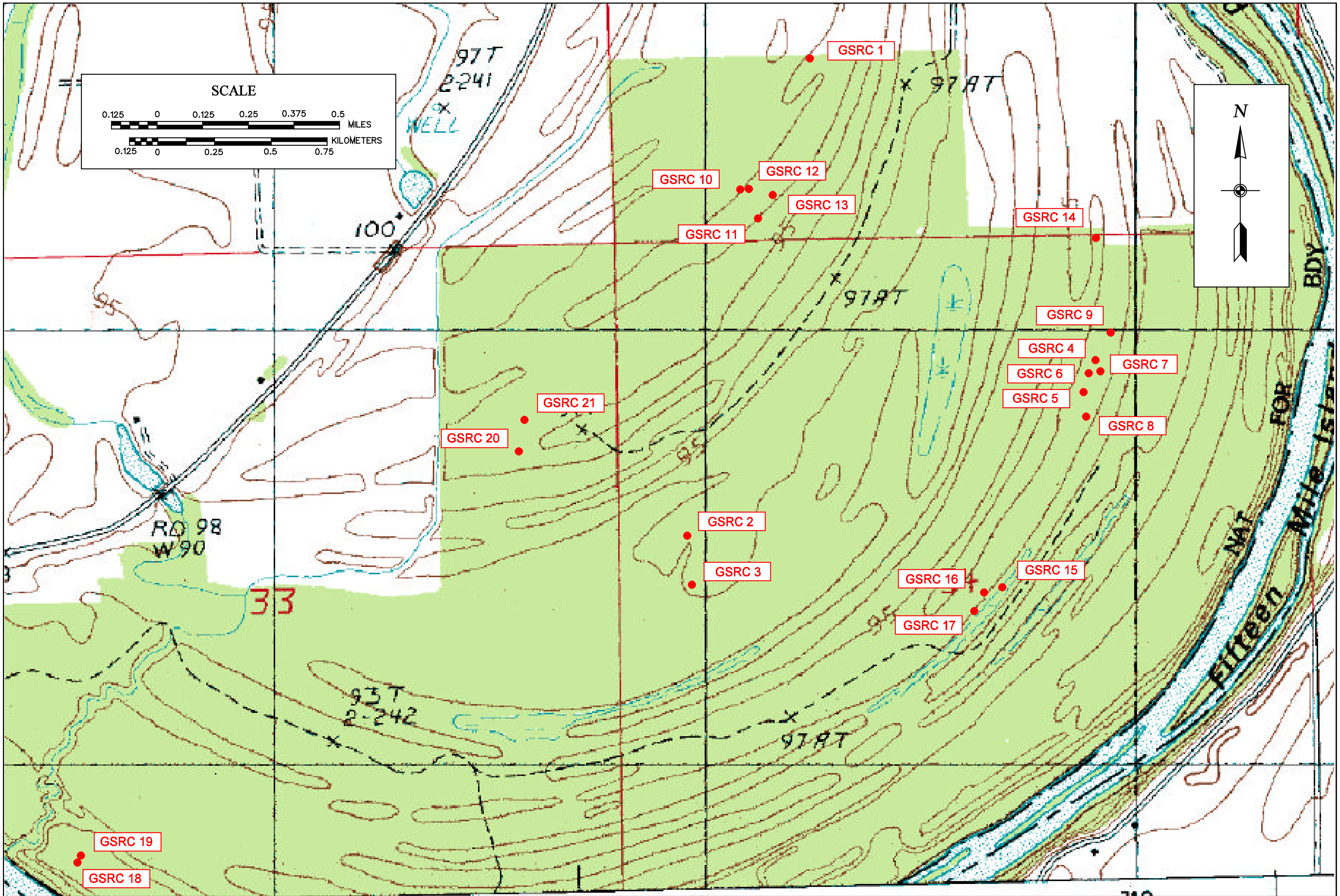

Figure 3: Pondberry Site Locations in Compartment 39 of Delta National Forest

GSRC / GULF SOUTH RESEARCH CORPORATION

SCALE: 1:12,000

DATE: August 2001

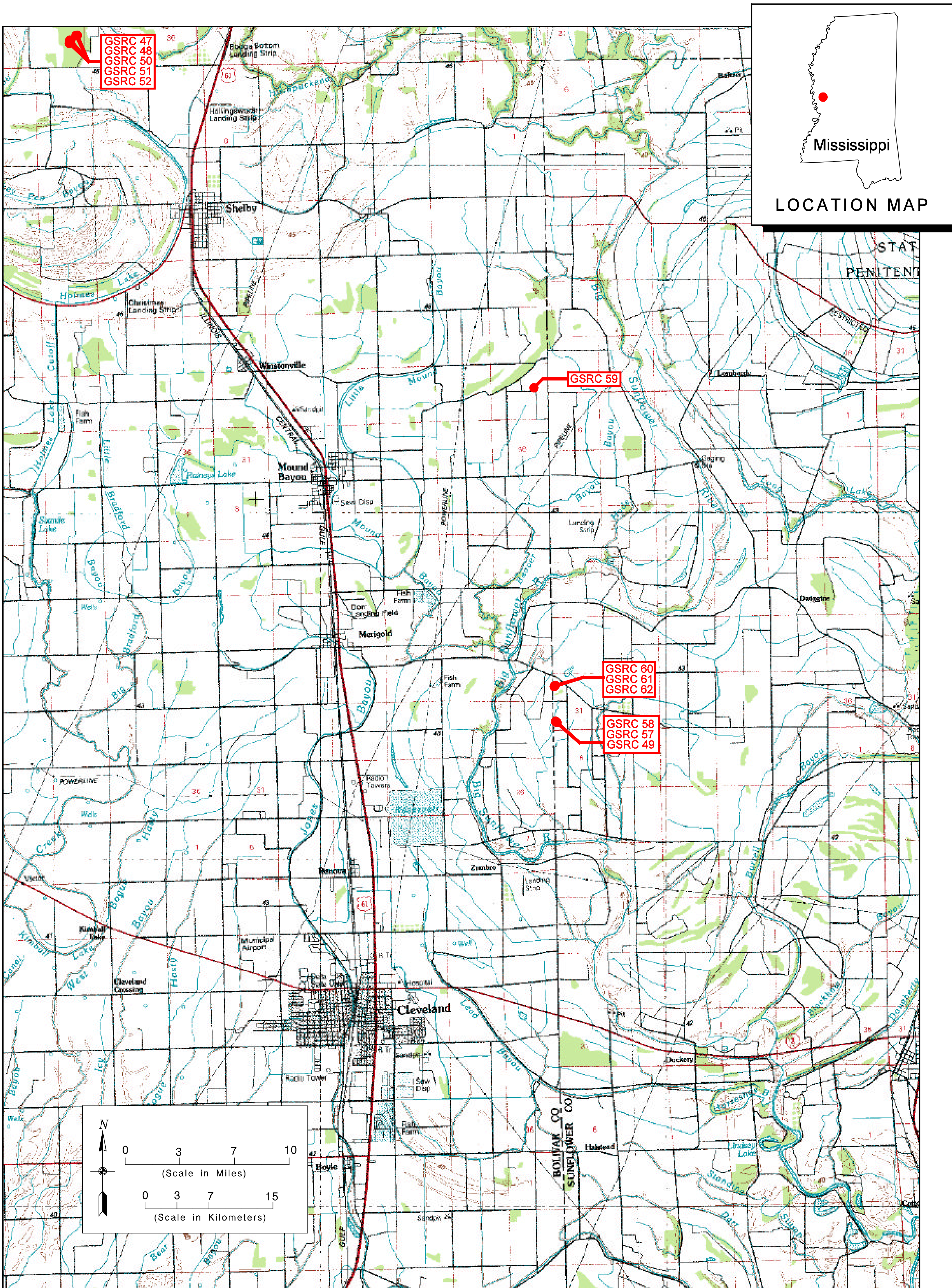

Figure 4: Pondberry Site Locations near Shelby/Merigold, Bolivar County

Scale: on map

Date: August 2001

GULF SOUTH RESEARCH CORPORATION

The elevations of the 62 colonies sampled ranged from 88 ft to 155 ft National Geodetic Vertical Datum (NGVD). The elevations of the 49 colonies surveyed on the DNF ranged from 88 to 99 ft NGVD. Based upon the surveyed elevations at each site and the slope-adjusted surface water elevations for various flood frequencies (Appendix B), these colonies occurred, on average, within the 6-year floodplain. The majority (56%) of the colonies in the DNF were found within the 2-5 year floodplain. The other colonies were distributed fairly evenly throughout the floodplains with 8% in the 0-2 year floodplain, 18% in the 5-10 year floodplain, 4% in the 10-15 year floodplain, and 14% in the 15-20 year floodplain. The correlation coefficient for pondberry density and flood frequency was calculated to be 0.063, which indicates that there is not a strong relationship between pondberry density and flood frequency. The elevations of the remaining 12 colonies surveyed at Shelby and Merigold ranged from 136 to 155 ft NGVD. All of these sites were located above the 100 year floodplain. Floodplain data for existing pondberry colonies are presented in Table 1. Floodplain data with the Yazoo Backwater Projects for pondberry colonies are presented in Table 2.

Table 1

Existing Flood Frequency Data for Pondberry Sites

Floodplain	**Delta National Forest**		**Shelby/Merigold**	
	Number of Colonies	**Percent**	**Number of Colonies**	**Percent**
0-2 year	4	8%	0	0
2-5 year	27	56%	0	0
5-10 year	9	18%	0	0
10-15 year	2	4%	0	0
15-20 year	7	14%	0	0
20-100 year	0	0	0	0
> 100 year	0	0	12	100%
Average	6-year floodplain		> 100 year floodplain	

Table 2
With Project Flood Frequency Data for Pondberry Sites:
"Yazoo Backwater Projects"

Floodplain	Delta National Forest		Shelby/Merigold	
	Number of Colonies	Percent	Number of Colonies	Percent
0-2 year	2	4%	--	--
2-5 year	6	12%	--	--
5-10 year	6	12%	--	--
10-15 year	1	2%	--	--
15-20 year	4	8%	--	--
20-100 year	16	33%		
> 100 year	14	29%	12	100%
Average	45-year floodplain		> 100 year floodplain	

4.3 Biological Data

4.3.1 Associated Vegetation

The three most common overstory species associated with the 62 pondberry colonies surveyed were sweetgum (*Liquidambar styraciflua*), willow oak (*Quercus phellos*), and Nuttall oak (*Quercus nuttallii*). The three most common understory species associated with the 62 colonies were sweetgum, red maple (*Acer rubrum* var. *drummondii*), and sugarberry (*Celtis laevigata*). The three most common shrub species associated with the pondberry sites sampled were sugarberry, swamp dogwood (*Cornus drummondii*), and deciduous holly (*Ilex decidua*). Other shrub species found in high abundance near the colonies were persimmon (*Diospyros virginiana*), American elm (*Ulmus americana*), red maple, and green ash (*Fraxinus pennsylvanica*). Poison ivy (*Toxicodendron radicans*) was found at all but two sites. The other most common vine and herb species found near the pondberry colonies were green briar (*Smilax* sp.), pepper vine (*Ampelopsis arborea*), and muscadine vine (*Vitis rotundifolia*). Virginia creeper (*Parthenocissus quinquefolia*), trumpet creeper (*Campsis radicans*), rattan (*Berchemia scandens*), blackberry (*Rubus* sp.), false nettle (*Boehermia cylindrica*), and lady's eardrops (*Brunnichia cirrhosa*) were also commonly found near the pondberry colonies. Appendix C presents the entire list of species found near the pondberry colonies.

The approximate percent canopy cover of the 62 colonies sampled ranged from 40% to 99% with an average of 87% (Figure 5). The percent canopy cover of the 50 colonies surveyed on the DNF ranged from 70% to 99% with an average of 90%. The percent canopy cover of the 12 remaining colonies ranged from 40% to 95% with an average of 77%. The correlation coefficient for pondberry density and percent canopy cover was calculated to be 0.124, which indicates that there is not a strong relationship between percent canopy cover and pondberry density.

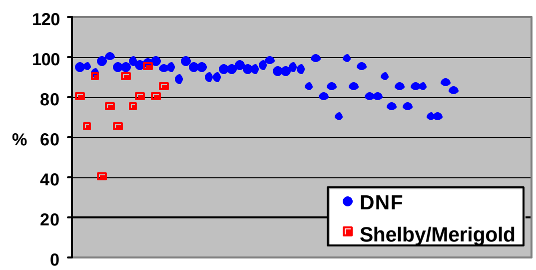

Figure 5

Percent Canopy Cover

The approximate diameter breast height (DBH) of the overstory tree species near the 62 pondberry colonies ranged from 9.3 inches (in) to 45.8 in with an average of 20.4 in (Figure 6). The correlation coefficient for elevation and DBH was calculated to be –0.007, which indicates that there is a slightly negative relationship, but that there is not a strong relationship between DBH and pondberry density.

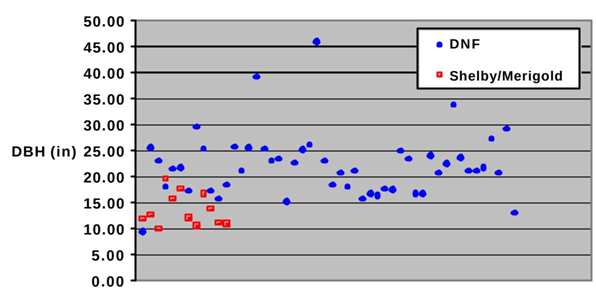

Figure 6

Overstory Tree Species Diameter (DBH)

The approximate percent herbaceous cover around the pondberry colonies ranged from 1% to 98% with an average of 63% (Figure 7). A correlation coefficient was not calculated for percent herbaceous cover and pondberry density due to the seasonal nature of herbaceous species.

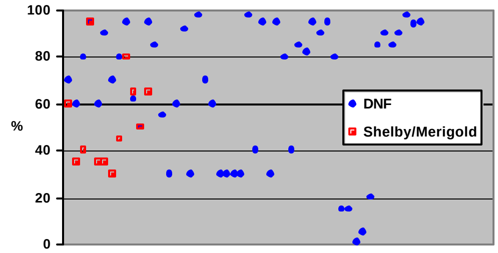

Figure 7

Percent Herbaceous Cover

4.3.2 Pondberry

The approximate height of the pondberry stems ranged from 10 in to 62 in with an average of 21 in. The correlation coefficient calculated for height of pondberry stems and elevation was 0.069, which indicated that there is not a strong relationship. The approximate diameter of the pondberry stems ranged from 0.037 in to 0.875 in with an average of 0.315 in. The correlation coefficient calculated for stem diameter and elevation was –0.014, which indicated that there was a slightly negative relationship, but that it was not very strong. Of the 62 colonies sampled, 27 had evidence of fungal damage, 42 had evidence of insect damage, and 52 had evidence of dieback. Twenty five (40%) of the colonies were classified as being in excellent condition, 29 (46%) as in good condition, 8 (13%) as in fair condition, and only one (<1%) in poor condition.

The density of pondberry stems ranged from 0.01 to 21 ft^2 with an average of 1.6 ft^2 for all 63 colonies sampled. The density of stems for the DNF ranged from 0.12 to 10.2 ft^2 with an average of 1.01; the remaining density for Shelby and Merigold ranged from 0.07 to 21 ft^2 with an average of 3.61 ft^2. The density of dead pondberry stems ranged from zero to 23.1 per ft^2 with an average of 0.65 per ft^2. The density of dead stems for the DNF ranged from zero to 2.07 per ft^2 with an average of 0.13 per ft^2; the remaining number of dead stems for Shelby and Merigold ranged from zero to 20 per ft^2 with an average of 2.63 per ft^2. The correlation coefficient calculated for the relationship between elevation and density of pondberry stems is 0.111, which indicated that there was not a strong relationship.

5.0 CONCLUSIONS

The results of this survey are similar to the results of the pondberry profile conducted by the USACE in 1991. They determined that a typical pondberry colony found within Mississippi Delta should occur on slight ridges in a ridge and swale community which is periodically flooded. Results from this current study indicated that the average elevations of pondberry colonies were within the 6-7 year floodplain. These results are similar to those from another study conducted by the USACE in 1996. Although this study determined that the pondberry colonies found within the DNF occurred within the 6-year floodplain on average, the majority of the colonies were located within the 2-5 year floodplain. However, the results of this study concur with previous reports that pondberry is more likely to be influenced by local precipitation and hydrology, rather than be overbank flooding. It must be noted that pondberry colonies located within a 5-year floodplain will not necessarily be flooded every five years. The presence of barriers, such as levees, roads, structures, or natural ridges will also affect the flooding near colonies even when a 5-year storm event occurs.

This study found that common associate species were similar to previous studies on the Mississippi pondberry populations. Common associate tree species were sweetgum, oaks, and elms while associate shrub species were sugarberry, swamp dogwood, and deciduous holly. However, it should be noted that the DNF is managed for oaks, so the importance of oaks as associate species may be over-estimated. The field team noted that spicebush was absent in areas where pondberry was present. The reverse was also true at Dahomey National Wildlife Refuge, where extensive colonies of spicebush, but not pondberry, were found.

Previous studies suggested that pondberry colonies in Mississippi are shade tolerant and probably shade dependent (USACE 1991a, b). A recent study by Devall *et al*. (nd) reported that the most vigorous colonies they observed were in locations with abundant light. However, these colonies were found in Georgia, in an entirely different habitat type. Devall *et al.* (nd) also reported that colonies in Mississippi were also found in areas of high canopy cover. The colonies surveyed in this study were found in areas of high percent canopy cover (average 90%). In addition, colonies located in areas of low percent canopy cover generally had a high abundance of competition from vines (Figure

8). This evidence suggests that pondberry colonies located in the DNF are indeed shade tolerant, and possibly shade dependent, as indicated by previous studies in this area (USACE 1991a, b).

Based on physical and biological data, there was no correlation between health of the colony, measured by either stem density, stem diameter, or stem height, and elevation. There was also no correlation between health of the colony, measured by stem density, and percent canopy cover or DBH. Therefore, it is difficult to predict where pondberry might be successful by using these quantifiable variables. Instead, evidence from this and previous studies suggest that, in general, pondberry is successful in areas of high percent canopy cover, in a ridge and swale community, and in areas that are mostly affected by local precipitation and hydrology.

Interestingly, pondberry colonies found in Bolivar County, approximately 65 miles north, differed from colonies found in the DNF. Colonies near Shelby were large, healthy colonies; however, one parcel of land contained colonies with very high amounts of dieback and dead stems (Figure 9). It was suggested at the June 22, 2000 workshop by Margaret Devall of the Center for Bottomland Hardwood Research that this die-off was caused by abnormally low temperatures during late winter 1999.

Pondberry colonies found near Merigold were in small parcels of forested land surrounded by crop fields, primarily rice fields. All of these colonies had been recently inundated with water from the nearby rice fields. Little dieback was observed in these areas; however, leaves were observed to be slightly wilted.

In conclusion, it is unlikely that pondberry would be affected by changes in the flood regime in the Yazoo Backwater Area. The 1991 profile, the 1996 Biological Assessment, and this study indicate that the pondberry colonies in the DNF are influenced more by local hydrology, rather than overbank flooding. The proposed flood control would not affect local hydrology and thus would not directly or indirectly affect the pondberry colonies. Since the colonies within the Yazoo Backwater project area are located on Federal lands (i.e., DNF), reductions in flood frequencies would not induce additional clearing of bottomland hardwood communities that could potentially impact pondberry populations.

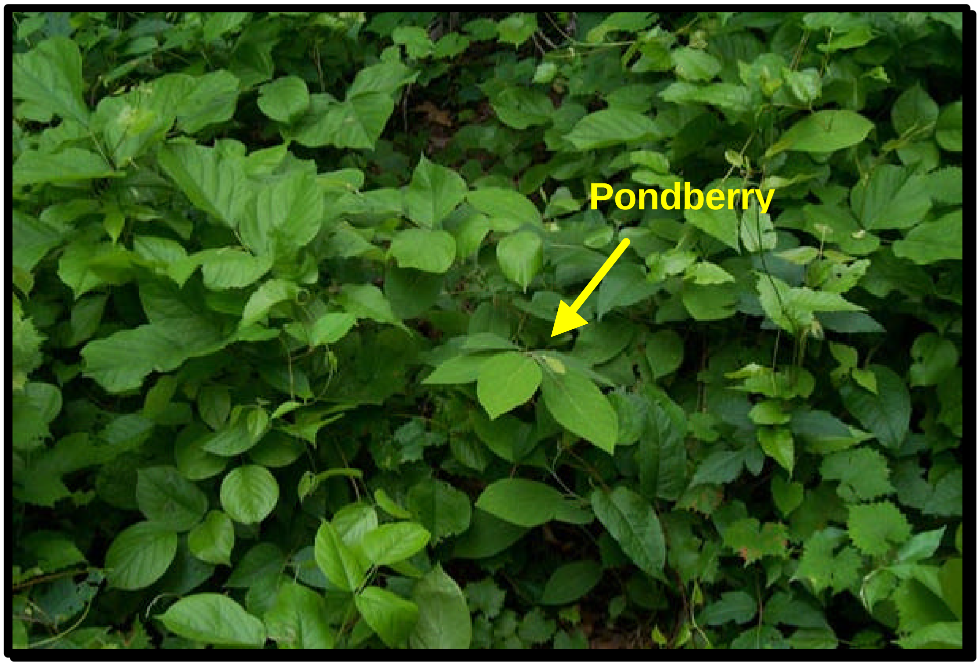

Figure 8

Pondberry colony with competition from vines.

Figure 9

Pondberry colony with dead stems in Bolivar County (near Shelby)

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7.0 LIST OF PREPARERS

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Jay Cline	Gulf South Research Corporation	Biology/Ecology	3 years NEPA studies	Data Collection
Tonya Bolton	Gulf South Research Corporation	Biology/Wildlife Management	1 year NEPA and related studies	Data Collection
Sheyna Wisdom	Gulf South Research Corporation	Biology	4 years natural resources and NEPA studies	Data Collection and Analysis, Report Preparation

AppendixA
Sample DataSheet

PONDBERRY DATA FORMS

Recorder: ______________ Sampler (s): ____________ Date: ____________
Location: ______________ Colony ID: ____________
Photo Number: ______________

PONDBERRY COLONY DATA

Number of clumps____________
Approx. no. of stems____________
Average height of stems (in)____________
Average no. stems within clumps____________
No. of female stems____________
No. of fruits on females____________
Average diameter of stems____________

Health of colony Excellent Good Fair Poor
Fungal damage Yes No
Insect damage Yes No
Dieback Yes No

TOPOGRAPHIC INFORMATION

GPS Location North__________ East__________ LMK#__________
Location description______________________________________
____
Water depth on plot____________
Distance to nearest body of water______________________________
General soil type____________
Munsell soil color:

ASSOCIATED VEGETATION

Percent Canopy Cover ____________
DBH____________
% herbaceous cover____________
Average tree stand maturity 6" 6-18" >18" Mixed

Overstory Species

Sweetgum	Willow oak	Cypress	______
Pecan sp.	American elm	Green ash	______
Overcup oak	Nuttall oak		______
Water oak	Water hickory		______

Understory Species

Sweetgum	Blackgum	Box elder	______
Red maple	Basswood	Dogwood	______
Sugar berry	Water oak	Red mulberry	______
Pecan sp.	Willow oak	Nuttall oak	______
American elm	Chestnut oak	Green ash	______

Shrubs

Sabal palm	Swamp dogwood	Red maple	Cedar elm	Box elder
Persimmon	Water oak	Red mulberry	Black hawthorn	
Deciduous holly	Willow oak	Am. Snowbell	Green ash	
Sugar berry	Chesnut oak	______		
Honey locust	Nuttall oak	______		
Pecan	American elm	______		

Herbs and Vines

Poison ivy	Rattan	Ebony spleenwort		
Muscadine	Rubus	Oxalis sp.	Moonseed	______
Virginia creeper	Lactuca	Sassafras	Smilax	______
Trumpet creeper	Spanish nettle	Persimmon	Rhyncocia	______
Pepper vine	False nettle	Lady's ear drops		______
Fox grape	Swamp violet	Pokeweed		

NOTES:

____
____
____
____

Appendix B
Pondberry Existing Conditions Data

PONDBERRY EXISTING CONDITIONS DATA

			Associated Vegetation				Colony Data									
Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)
GSRC 01	39	11-May-00	94.8	9.25	70%	Mixed	1	2	56	0.0357	2.00	0	0	0	0.0000	0.1	12
GSRC 02	39	11-May-00	95.08	25.40	60%	6-18	2	36	300	0.1200	18.00	0	0	0	0.0000	0.3125	24
GRSC 03	39	11-May-00	91.68	23.00	80%	6-18	3	70	2000	0.0350	23.33	2	17	4	0.0020	0.3125	21
GSRC 04	39	11-May-00	97.87	18.00	95%	>18	2	142	1036	0.1371	71.00	0	0	0	0.0000	0.3125	13
GSRC 05	39	11-May-00	99.96	21.40	60%	Mixed	2	8	59	0.1356	4.00	0	0	0	0.0000	0.3125	10
GSRC 06	39	11-May-00	94.8	21.50	90%	Mixed	4	10	123	0.0813	2.50	0	0	0	0.0000	0.3125	16
GSRC 07	39	12-May-00	94.8	17.20	70%	Mixed	1	14	361	0.0389	14.00	0	0	0	0.0000	0.3125	13
GSRC 08	39	12-May-00	97.92	29.50	80%	6-18	1	6	150	0.0400	6.00	0	0	0	0.0000	0.3125	14
GSRC 09	39	12-May-00	95.84	25.20	95%	>18	8	133	400	0.3325	16.63	4	21	5	0.0125	0.3125	24
GRSR 10	39	12-May-00	96.88	17.10	62%	>18	7	11	200	0.0550	1.57	2	4	0	0.0000	0.3125	15
GSRC 11	39	12-May-00	97.82	15.50	50%	>18	2	37	504	0.0734	18.50	0	0	0	0.0000	0.3125	22
GSRC 12	39	12-May-00	94.16	18.30	95%	>18	5	21	1080	0.0194	4.20	3	48	2	0.0019	0.3125	17
GSRC 13	39	12-May-00	94.8	25.60	85%	>18	1	6	504	0.0119	6.00	1	1	1	0.0020	0.4375	23
GSRC 14	39	15-May-00	88.89	21.09	55%	>18	3	13	150	0.0867	4.33	4	4	5	0.0333	0.5	14
GSRC 15	39	15-May-00	97.9	25.45	30%	>18	8	143	3990	0.0358	17.88	0	0	4	0.0010	0.25	12
GSRC 16	39	15-May-00	94.8	39.00	60%	6-18	3	40	600	0.0667	13.33	0	0	3	0.0050	0.3125	22
GSRC 17	39	15-May-00	94.8	25.30	92%	>18	14	262	2150	0.1219	18.71	1	1	19	0.0088	0.25	30
GSRC 18	39	16-May-00	89.67	23.00	30%	Mixed	1	424	1836	0.2309	424.00	0	0	63	0.0343	0.5	27
GSRC 19	39	16-May-00	89.67	23.20	98%	>18	4	20	1410	0.0142	5.00	6	14	0	0.0000	0.5	24
GSRC 20	39	16-May-00	93.76	15.00	70%	Mixed	3	218	2546	0.0856	72.67	6	13	50	0.0196	0.0375	17
GSRC 21	39	16-May-00	93.62	22.50	60%	>18	1	72	836	0.0861	72.00	0	0	16	0.0191	0.625	15
GSRC 22	39	17-May-00	95.84	25.00	30%	Mixed	3	34	1450	0.0234	11.33	0	0	2	0.0014	0.125	18

PONDBERRY EXISTING CONDITIONS DATA

			Associated Vegetation				Colony Data										
Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)
GSRC 23	2	17-May-00	93.76	26.00	30%	Mixed	1	3	21	0.1429	3.00	0	0	0	0.0000	0.25	14
GSRC 24	2	17-May-00	93.76	45.80	30%	Mixed	5	16	450	0.0356	3.20	0	0	2	0.0044	0.25	11
GSRC 25	2	17-May-00	95.84	22.83	30%	>18	1	2	84	0.0238	2.00	0	0	0	0.0000	0.25	15
GSRC 26	4	17-May-00	98.08	18.20	98%	>18	13	148	5896	0.0251	11.38	0	0	0	0.0000	0.625	24
GSRC 27	2	17-May-00	92.72	20.50	40%	Mixed	4	15	264	0.0568	3.75	0	0	0	0.0000	0.25	13
GSRC 28	4	17-May-00	92.72	17.80	95%	>18	6	48	765	0.0627	8.00	0	0	1	0.0013	0.875	26
GSRC 29	3	18-May-00	94.8	21.00	30%	Mixed	11	485	8625	0.0562	44.09	0	0	90	0.0104	0.625	22
GSRC 30	3	18-May-00	93.76	15.70	95%	Mixed	4	300	5016	0.0598	75.00	0	0	42	0.0084	0.5	22
GSRC 31	3	23-May-00	85	16.60	80%	Mixed	10	1800	9000	0.2000	180.00	100	20	40	0.0044	0.5	20
GSRC 32	1	23-May-00	99	16.10	40%	6-18	1	9	112	0.0804	9.00	0	0	2	0.0179	0.125	18
GSRC 33	1	23-May-00	80	17.50	85%	>18	2	22	1053	0.0209	11.00	1	1	0	0.0000	0.125	17
GSRC 34	1	23-May-00	85	17.30	82%	6-18	1	10	252	0.0397	10.00	0	0	0	0.0000	0.125	14
GSRC 35	1	23-May-00	70	24.80	95%	>18	3	25	270	0.0926	8.33	0	0	0	0.0000	0.2	16
GSRC 36	7	23-May-00	99	23.30	90%	>18	1	11	256	0.0430	11.00	1	10	1	0.0039	0.125	24
GSRC 37	7	23-May-00	85	16.50	95%	>18	7	161	5100	0.0316	23.00	15	60	12	0.0024	0.375	24
GSRC 38	7	23-May-00	95	16.50	80%	Mixed	1	31	990	0.0313	31.00	0	0	1	0.0010	0.2	20
GSRC 39	16	24-May-00	80	23.80	15%	>18	1	12	210	0.0571	12.00	7	87	2	0.0095	0.2	26
GSRC 40	16	24-May-00	80	20.50	15%	>18	1	5	286	0.0175	5.00	0	0	0	0.0000	0.05	12
GSRC 41	16	24-May-00	90	22.30	1%	Mixed	3	46	660	0.0697	15.33	0	0	4	0.0061	0.2	24
GSRC 42	16	24-May-00	75	33.60	5%	>18	1	2064	1850	1.1157	2064.00	30	40	344	0.3333	0.5	36

PONDBERRY EXISTING CONDITIONS DATA

			Associated Vegetation				Colony Data										
Colony ID	Compartment	Date	Percent Canopy Cover	DBH (in)	Herbaceous cover	Tree Stand Maturity	No. Clumps	No. Stems	Area of Plot (ft^2)	Stems per ft^2	Stems within Clump	No. Females	No. Fruits	No. Dead Stems	Dead Stems per ft^2	Avg. Diameter of Stems (in)	Avg. Height of Stems (in)
GSRC 43	16	24-May-00	85	23.50	20%	>18	1	3791	2400	1.5796	3791.00	109	141	446	0.6667	0.4	42
GSRC 44	38	24-May-00	75	21.00	85%	>18	5	72	6160	0.0117	14.40	0	0	0	0.0000	0.2	14
GSRC 45	47	24-May-00	85	21.00	90%	Mixed	1	398	357	1.1148	398.00	0	0	83	0.2325	0.325	41
GSRC 46	47	24-May-00	85	21.60	85%	Mixed	8	258	2610	0.0989	32.25	6	37	6	0.0023	0.2	18
GSRC 47	Shelby	19-Jun-00	80	11.86	60%	6-18	1	125	3850	0.0325	125.00	0	0	4292	1.1148	0.3125	27
GSRC 48	Shelby	19-Jun-00	65	12.50	35%	Mixed	1	115	8400	0.0137	115.00	0	0	7023	0.8361	0.5	62
GSRC 49	Merigold	19-Jun-00	90	9.85	40%	Mixed	4	212	1500	0.1413	53.00	0	0	0	0.0000	0.25	18
GSRC 50	Shelby	8-Jun-00	40	19.50	95%	6-18	1	Unable to Calculate	Unable to Acquire	0.7700	Unable to Calculate	0	0	Unable to Calculate	0.2100	0.875	39
GSRC 51	Shelby	8-Jun-00	75	15.70	35%	Mixed	1	900	968	0.9298	900.00	0	0	855	0.8833	0.2	32
GSRC 52	Shelby	8-Jun-00	65	17.50	35%	>18	1	219	Unable to Acquire	Unable to Calculate	219.00	0	0	38	Unable to Calculate	0.375	29
GSRC 53	14	9-Jun-00	70	27.25	90%	Mixed	6	91	2400	0.0379	15.17	0	0	31	0.0129	0.15	18
GSRC 54	25	9-Jun-00	70	20.60	98%	6-18	1	47	770	0.0610	47.00	0	0	7	0.0091	0.2	29
GSRC 55	30	9-Jun-00	87	29.00	94%	6-18	1	153	456	0.3355	153.00	9	40	14	0.0307	0.2	16
GSRC 56	28	9-Jun-00	83	13.00	95%	Mixed	1	94	2100	0.0448	94.00	0	0	2	0.0010	0.2	26
GSRC 57	Merigold	19-Jun-00	90	12.00	30%	>18	6	199	1400	0.1421	33.17	0	0	64	0.0457	0.25	13
GSRC 58	Merigold	19-Jun-00	75	10.44	45%	Mixed	2	177	1750	0.1011	88.50	0	0	51	0.0291	0.25	18
GSRC 59	Merigold	20-Jun-00	80	14.48	80%	Mixed	1	500	2400	0.2083	500.00	0	0	125	0.0521	0.25	17
GSRC 60	Merigold	20-Jun-00	95	13.67	65%	Mixed	1	37	200	0.1850	37.00	0	0	8	0.0400	0.25	21
GSRC 61	Merigold	20-Jun-00	80	10.94	50%	Mixed	4	79	2015	0.0392	19.75	0	0	25	0.0124	0.375	29
GSRC 62	Merigold	20-Jun-00	85	10.75	65%	Mixed	3	250	3500	0.0714	83.33	0	0	54	0.0154	0.375	32

PONDBERRY EXISTING CONDITIONS DATA

Colony ID	Fungal Damage (1 = Presence, 0 = Absence)	Insect Damage (1 = Presence, 0 = Absence)	Dieback (1 = Presence, 0 = Absence)	Health of Colony	Soil Type	Munsell Soil Color	Distance to Nearest Water (ft)	Iron Rod Elevation	Average Colony Elevation	Existing Conditions Flooding Frequency (years)	Evidence of localized depression (1 = Presence, 0 = Absence)	Comments
GSRC 01	1	0	0	Excellent	clay	0-2 organic; 2-depth 10YR6/2, 50% mottling 10YR5/6	70	94.55	94.69	4.5	1	332 m from parking area; 120 ft from GPS point
GSRC 02	1	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 40% mottling 10YR6/8	50	91.05	91.20	1.5	1	
GRSC 03	1	1	1	Good	clay	0-2 organic; 2-depth 10YR6/1, 40% mottling 10YR6/8	70	91.65	91.50	1.5	1	lots of competition with Rhyncocia and poison ivy
GSRC 04	0	0	1	Excellent	grainy clay	0-2 organic; 2-depth 7.5YR, 10% mottling	94	97.44	97.65	16.0	1	no water in drain
GSRC 05	0	1	0	Good		0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	80	94.87	95.09	5.0	1	no water in drain; 115 SW from GRSC 04
GSRC 06	0	0	0	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	96.39	96.37	9.0	1	no water in drain
GSRC 07	0	0	1	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	96.93	95.94	7.0	1	no water in drain
GSRC 08	0	0	1	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	70	95.7	95.44	6.0	1	no water in drain
GSRC 09	1	0	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	37	97.22	97.28	15.0	1	no water in drain; lots of competition from vines
GRSR 10	0	0	1	Good	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/1	107	93.79	94.16	4.0	1	no water in drain; leaf rolled up with insect web
GSRC 11	1	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	177	96.21	95.98	7.5	1	no water in drain
GSRC 12	0	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	147	95.63	96.10	7.5	1	no water in drain
GSRC 13	1	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	175	96.53	96.80	11.0	1	less competion than others, right in the middle of old logging road
GSRC 14	1	0	1	Excellent	clay	0-2 organic; 2-5 10YR4/2; 5-depth 10YR5/1, 30% mottling 10YR4/6	34	93.7	93.86	3.5	1	60 ft from field near the ditch
GSRC 15	1	1	1	Good	clay	0-2 organic; 2-5 10YR4/2; 5-depth 10YR5/1, 30% mottling 10YR4/6	70	94.32	93.85	3.5	1	short stems and very spread out; located on ridge alongside a depression with standing water
GSRC 16	1	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	78	92.43	92.72	2.5	1	located on ridge alongside a depression with standing water
GSRC 17	1	1	1	Excellent	clay	0-2 organic; 2-depth 10YR6/1, 10% mottling 10YR6/8	40	92.77	93.69	3.5	1	insect use of leaves with web; very large and spread out colony, very thick vegetation and near depression with standing water
GSRC 18	1	1	1	Excellent	clay	0-1 organic; 1-3 10YR3/1, 10% mottling 10YR3/4; 3-12 10YR5/1, 20% mottling	40	92.28	92.66	2.5	1	good colony in fairly open clearing; chlorosis; very dense clump with little vegetation within clump, near Yazoo River
GSRC 19	1	1	0	Good	clay	0-1 organic; 1-3 10YR3/1, 10% mottling 10YR3/4; 3-12 10YR5/1, 20% mottling	89	91.07	91.98	2.0	1	tall sassafras and pokeweed within clump; very distinct clumps under little canopy; lots of competition with thick vines
GSRC 20	1	1	0	Excellent	clay	0-2 organic; 2-4 10YR3/1; 4-12 10YR3/1; 10% mottling 10YR6/8	118	92.95	93.58	3.0	1	in one large clump with a few others scattered
GSRC 21	0	1	0	Good	clay	0-2 organic; 2-4 10YR3/1; 4-12 10YR3/1; 10% mottling 10YR6/8	65	92.47	91.68	2.0	1	insect use of leaf
GSRC 22	1	1	1	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	Unable to Determine	98.34	98.52	17.0	1	very spread out and individual stems

PONDBERRY EXISTING CONDITIONS DATA

	1 = Presence 0 = Absence										1 = Presence 0 = Absence	
Colony ID	Fungal Damage	Insect Damage	Dieback	Health of Colony	Soil Type	Munsell Soil Color	Distance to Nearest Water (ft)	Iron Rod Elevation	Average Colony Elevation	Existing Conditions Flooding Frequency (years)	Evidence of localized depression	Comments
GSRC 23	0	0	1	Fair	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	Unable to Determine	98.2	98.22	15.0	1	small colony
GSRC 24	0	1	1	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	Unable to Determine	98.15	98.24	15.0		insect use of leaf; very scattered clumps
GSRC 25	0	1	0	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	Unable to Determine	98.06	98.11	14.0		very small colony
GSRC 26	1	1	1	Good	clay	0-2 organic; 2-5 10YR3/1; 5-6 10YR4/2; 6-12 10YR6/3, 10% mottling 10YR5/6	Unable to Determine	99.57	98.18	15.0	1	huge colony with distinct clumps on ridge NE of bayou, lots of competition with vines; fairly tall stems; 100 ft from power line road
GSRC 27	0	1	0	Good	clay	0-2 organic; 2-5 10YR3/1; 5-10 10YR4/1, 10% mottling 10YR5/8	Unable to Determine	98.1	98.31	16.0	1	small colony within boundary; stems healthy but scattered
GSRC 28	0	0	1	Good	clay	0-1 organic; 1-3 organic-rich soil; 3-6 10YR 5/4; 6-10 10YR6/3, 10% mottling, 10YR6/6	Unable to Determine	96.86	97.07	7.0	1	colony is E (130) of boundary line marked with organge tape; overtaken by briars
GSRC 29	0	0	0	Excellent	clay	0-1 organic; 1-3 10YR3/1; 3-8 10YR5/2; 8-12 10YR6/1, 10% mottling, 10YR5/6	Unable to Determine	96.1	96.27	4.5	1	huge area with many clumps, small red bugs on several leaves; insect use of leaves with web; good diversity of plant sizes (2.5 ft-1
GSRC 30	0	1	1	Excellent	clay	0-1 organic; 1-3 10YR3/1; 3-8 10YR5/2; 8-12 10YR6/1, 10% mottling, 10YR5/6	Unable to Determine	96.03	96.10	4.0	1	big colony with tall plants; one clump had plant 4'10" tall; thick vines but still healthy colony; depressions throughout area
GSRC 31	1	1	1	Excellent	clay loam	0-2 organic; 2-12 10YR5/4, 40% mottling, 7.5YR6/6	Unable to Determine	96.19	96.08	4.0	1	big clump of females with lots of fruit; very large colony with tall stems and little competition; 31a is SSW of plot flagged separately
GSRC 32	0	0	1	Good	clay	0-2 organic; 2-12 10YR5/2, 25% mottling, 10YR 6/6	Unable to Determine	96.21	96.16	4.0	1	insect use of leaf; GSRC32-34 colonies very close but still very distinct colonies; in the middle of a cutover area
GSRC 33	0	0	1	Good	clay loam	0-2 organic; 2-12 10YR5/2, 25% mottling, 10YR 6/6	Unable to Determine	95.81	96.17	4.0	1	lots of competition from vines and trumpet creeper; also in middle of clear cut
GSRC 34	0	0	1	Good	clay loam	0-2 organic; 2-12 10YR5/2, 25% mottling, 10YR 6/6	Unable to Determine	95.87	95.90	3.5	1	60 yards from a cypress tree, 50 ft from clear cut
GSRC 35	0	0	1	Good	clay loam	0-2 organic; 2-12 10YR5/2, 25% mottling, 10YR 6/6	Unable to Determine	95.66	95.67	3.0		35 ft (243) from boundary is one small plant; 2 garder snakes seen; in a clear cut circle; logging road within 25ft
GSRC 36	0	1	1	Good	clay loam	0-3 organic; 3-12 10YR5/1, 30% mottling, 7.5YR5/6	Unable to Determine	96.17	96.32	4.0	1	lots of competition from everything- just south of sweetgum research area
GSRC 37	1	1	1	Excellent	clay loam	0-3 organic; 3-12 10YR5/3, 40% mottling, 10YR6/6	Unable to Determine	96.91	97.02	6.0	1	very thick with lots of competition; huge range of plants-diameter .25-.5, height 2"-5'3", 3-60 fruits on females
GSRC 38	0	1	0	Good	loamy clay	0-3 organic; 3-12 10YR5/3, 40% mottling, 10YR6/6	Unable to Determine	96.95	97.08	6.0	1	100 ft E of GSRC 37; thick understory but less competition with vines than others in this compartment; near edge of cane field
GSRC 39	0	1	1	Excellent	clay loam	0-3 organic; 3-12 10YR4/2, 45% mottling, 10YR5/6	Unable to Determine	94.38	94.56	2.5	1	200 ft S of field, very open area with tall tress and little growth on ground
GSRC 40	0	0	1	Good	clay loam	0-3 organic; 3-12 10YR4/2, 45% mottling, 10YR5/6	Unable to Determine	94.05	94.21	2.0	1	20 ft from GSRC 39, very open area; 110 ft from small pond, in a depression with water marks on trees
GSRC 41	1	1	1	Excellent	loamy clay	0-3 organic; 3-12 10YR5/3, 40% mottling, 10YR6/6	Unable to Determine	93.93	94.28	2.0	1	very open area with little herbaceous cover; 200 ft due South from GSRC 40; very healthy large colonies; 41a is 1 plant outside of plot, 41b is 2 plants farther south from 41a
GSRC 42	1	1	1	Excellent	clay loam	0-3 organic; 3-12 10YR5/2, 35% mottling, 10YR5/6	Unable to Determine	93.85	94.20	2.0	1	plot sub-sampled; huge, very healthy colonies throughout entire area with little herbaceous cover; very tall trees; pondberry dispersed in between the very large clumps

PONDBERRY EXISTING CONDITIONS DATA

Colony ID	Fungal Damage (1 = Presence, 0 = Absence)	Insect Damage	Dieback	Health of Colony	Soil Type	Munsell Soil Color	Distance to Nearest Water (ft)	Iron Rod Elevation	Average Colony Elevation	Existing Conditions Flooding Frequency (years)	Evidence of localized depression (1 = Presence, 0 = Absence)	Comments
GSRC 43	1	1	1	Excellent	clay loam	0-3 organic; 3-12 10YR5/2, 35% mottling, 10YR5/6	Unable to Determine	94.13	94.46	2.5	1	plot sub-sampled; huge, very healthy colonies throughout entire area with little herbaceous cover; very tall trees; pondberry dispersed in between the very large clumps; very little competition
GSRC 44	1	1	1	Good	clay loam	0-3 organic; 3-12 10YR4/2, 30% mottling, 10YR4/6	62	93.07	93.19	3.0	1	closest water is stump hole; in the middle of a tree stand that is the middle of a clear cut area; some competition with vines
GSRC 45	1	1	1	Excellent	clay loam	0-4 organic; 4-12 10YR5/3, 30% mottling, 7.5YR5/6	Unable to Determine	94.52	94.47	4.5		plot sub-sampled; 100 ft from edge of forest-right in corner near clear cut
GSRC 46	1	1	1	Good	clay loam	0-4 organic; 4-12 10YR5/3, 30% mottling, 7.5YR5/6	Unable to Determine	94.52	94.30	4.0	1	30ft from GSRC 45; one female has lots of dieback; this colony is very spread out; in a small depression
GSRC 47	1	1	1	Poor	clay	0-2 organic; 2-4 10YR4/1; 4-12 qoYR4/1, 30% mottling, 10YR5/6	Unable to Determine	154.64	154.80	>100-YEAR	1	whole area sub-sampled and plot sub-sampled; lots of dieback and dead stems; in area that frequently floods
GSRC 48	1	1	1	Fair	clay	0-2 organic; 2-4 10YR4/1; 4-12 qoYR4/1, 30% mottling, 10YR5/6	Unable to Determine	154.57	154.78	>100-YEAR	1	whole area sub-sampled and plot sub-sampled; lots of dieback and dead stems; in area that frequently floods
GSRC 49	1	1	1	Fair	clay loam	0-1 organic; 1-12 10YR4/2	Unable to Determine	137.95	135.93	>100-YEAR	1	all submerged in water from nearby rice fields; pondberry wilted
GSRC 50	0	1	1	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	Unable to Determine	Not Available	154.50	>100-YEAR	1	plot sub-sampled; ground was dry but can tell that it normally holds water; very thick clumps within entire area; quite a few dead stems and dieback
GSRC 51	0	0	1	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	Unable to Determine	Not Available	154.50	>100-YEAR	1	plot sub-sampled; this colony had slightly more competition from vines; next to road\
GSRC 52	0	0	1	Excellent	clay	0-2 organic; 2-8 10YR5/1, 25% mottling, 10YR6/8; 8-12 gley 5N	Unable to Determine	Not Available	154.50	>100-YEAR	1	whole plot measured; ground definitely holds water
GSRC 53	0	0	1	Good	clay	0-2 organic; 2-12 10YR4/1	Unable to Determine	91.01	91.43	LOCATED IN GREEN TREE	1	plot sub-sampled; in small hummock; quite a bit of dieback and dead stems
GSRC 54	1	1	1	Good	clay	0-12 10YR5/1, 15% mottling, 10YR4/6	Unable to Determine	89.62	89.88	0.8	1	plot sub-sampled; slight slolpe S to N; dense smilax; understory more dense than overstory; low dieback
GSRC 55	0	1	1	Fair	clay	0-3 organic; 3-12 10YR5/1, 25% mottling, 10YR5/6	Unable to Determine	95.57	95.59	4.0	1	plot sub-sampled;high percent shrub canopy; snail eating several plants; stems are very scattered and have lots of competition
GSRC 56	0	0	1	Excellent	clay loam	0-2 organic; 2-12 10YR5/1, 25% mottling, 10YR5/6	Unable to Determine	88.17	88.26	0.7	1	plot sub-sampled; herbaceous cover outside colony low outside of colony; thickest stand of pondberry measured
GSRC 57	0	1	1	Fair	clay loam	0-1 organic; 1-12 10YR4/2	0	137.95	135.98	>100-YEAR	1	submerged in water from nearby rice fields; plants wilted
GSRC 58	0	1	1	Fair	clay loam	0-1 organic; 1-12 10YR4/2	0	137.95	135.93	>100-YEAR	1	submerged in water from nearby rice fields; plants wilted
GSRC 59	0	1	1	Fair	clay loam	0-1 organic; 1-12 10YR4/1, 10% mottling, 10YR/6	0	137.88	135.81	>100-YEAR	1	submerged in water from nearby rice fields very recently (within this week); plants wilted
GSRC 60	0	1	1	Fair	clay loam	0-1 organic; 1-12 10YR4/1, 10% mottling, 10YR/6	10	138.84	136.03	>100-YEAR	1	near rice fields; some area surrounding pondberry submerged but not in actual plants yet; some wilting
GSRC 61	0	1	1	Good	clay loam	0-1 organic; 1-12 10YR5/1, 10% mottling, 10YR/6	25	138.84	136.25	>100-YEAR	1	plot sub-sampled; right next to rice field with standing water
GSRC 62	0	1	1	Good	clay loam	0-1 organic; 1-12 10YR5/1, 10% mottling, 10YR/6	15	135.99	136.21	>100-YEAR	1	large colony with 3 distinct clumps; no standing water but flooded often; in the middle of 3 wheat fields and 1 rice field

Appendix C
List of Associated Species

APPENDIX C

Number of Colonies	Common Name	Scientific Name
OVERSTORY		
41	Sweetgum	*Liquidambar styraciflua*
6	Pecan sp.	*Carya sp.*
14	Overcup oak	*Quercus lyrata*
12	Water oak	*Quercus nigra*
19	Willow oak	*Quercus phellos*
8	American elm	*Ulmus americana*
17	Nuttall oak	*Quercus nuttallii*
12	Water hickory	*Carya aquatica*
3	Cypress	*Taxodium distichum*
7	Green ash	*Fraxinus pennsylvanica*
4	Sugar berry	*Celtis laevigata*
4	Persimmon	*Diospyros virginiana*
1	Red maple	*Acer rubrum var. drummondii*
1	Southern red oak	*Quercus falcata* var. *falcata*
UNDERSTORY		
39	Sweetgum	*Liquidambar styracuflua*
15	Red maple	*Acer rubrum var. drummondii*
25	Sugar berry	*Celtis laevigata*
5	Pecan sp.	*Carya sp.*
13	American elm	*Ulmus americana*
3	Blackgum	*Nyssa sylvatica var. biflora*
7	Basswood	*Tilia heterophylla*
2	Water oak	*Quercus nigra*
7	Willow oak	*Quercus nigra*
1	Chestnut oak	*Quercus prinus*
7	Box elder	*Acer negundo*
3	Swamp dogwood	*Cornus drummondii*
1	Red mulberry	*Morus rubra*
4	Nuttall oak	*Quercus nuttallii*
5	Green ash	*Fraxinus pennsylvanica*
2	Sassafras	*Sassafras albidum*
5	Persimmon	*Diospyros virginiana*
1	Mockernut hickory	*Carya tomentosa*
1	Deciduous holly	*Ilex decidua*
1	Cedar elm	*Ulmus crassifolia*
2	Water hickory	*Carya aquatica*
1	Southern red oak	*Quercus falcata* var. *falcata*

Number of Colonies	Common Name	Scientific Name
SHRUBS		
20	Sabal palm	*Sabal minor*
30	Persimmon	*Diospyros virginiana*
38	Deciduous holly	*Ilex decidua*
51	Sugar berry	*Celtis laevigata*
5	Honey locust	*Gleditsia triacanthos*
15	Pecan	*Carya sp.*
39	Swamp dogwood	*Cornus drummondii*
13	Water oak	*Quercus nigra*
22	Willow oak	*Quercus phellos*
2	Chestnut oak	*Quercus prinus*
2	Overcup oak	*Quercus lyrata*
12	Nuttall oak	*Quercus nuttallii*
31	American elm	*Ulmus americana*
29	Red maple	*Acer rubrum var. drummondii*
20	Red mulberry	*Morus rubra*
16	Am. Snowbell	*Styrax americana*
13	Cedar elm	*Ulmus crassifolia*
20	Black hawthorn	*Crataegus douglasii*
34	Green ash	*Fraxinus pennsylvanica*
20	Box elder	*Acer negundo*
14	Sweetgum	*Liquidambar styracuflua*
4	Blackgum	*Nyssa sylvatica var. biflora*
2	Green hawthorn	*Crataegus viridis*
2	Sassafras	*Sassafras albidum*
4	Winged elm	*Ulmus alata*
1	Mimosa	*Albizia julibrissin*
1	American elder	*Sambucus canadensis*
2	Buttonbush	*Cephalanthus occidentalis*
2	Swamp privet	*Forestiera acuminata*
1	Mockernut hickory	*Carya tomentosa*
HERBS AND VINES		
61	Poison ivy	*Toxicodendron radicans*
49	Muscadine	*Vitis rotundifolia*
41	Virginia creeper	*Parthenocissus quinquefolia*
40	Trumpet creeper	*Campsis radicans*
47	Pepper vine	*Ampelopsis arborea*
24	Fox grape	*Vitis labrusca*
38	Rattan	*Berchemia scandens*
31	Blackberry	*Rubus sp.*
23	Wild lettuce	*Lactuca sp.*
29	Spanish nettle	

Number of Colonies	Common Name	Scientific Name
32	False nettle	*Boehermia cylindrica*
11	Eupatorium	*Eupatorium sp.*
8	Ebony spleenwort	
5	Sorrel	*Oxalis sp.*
5	Sassafras	*Sassafras albidum*
26	Persimmon	*Diospyros virginiana*
37	Lady's ear drops	*Brunnichia cirrhosa*
8	Moonseed	*Menispermum canadense*
50	Green briar	*Smilax sp.*
32	Rhynchosia	*Rynchosia tomentosa*
14	Pokeweed	*Phytolacca americana*
21	Swamp violet	*Viola sp.*
1	Hydrocotyle	*Hydrocotyle bonariensis*
2	Goldenrod	*Solidago sp.*
17		*Chaerophyllum tainturieri*
16	Grass	*Carex sp.*
1	Red-eyed bladder wort	*Utricularia sp.*
6	dayflower	*Commelina sp.*
1	Sedge	*Cyperaceae sp.*
4	Smartweed	*Polygonum sp.*
1	Wild strawberry	*Fragaria vesca*
1	Panic grass	*Panicum sp.*
3	Mock bishop weed	*Ptilimnium sp.*
2	Lizard tail	*Saurrurus cernuus*
1	Curly dock	*Rumex crispus*
1	Dogbane	*Trachelospermum difforme*

Appendix C
Review of Appendix 14: Pondberry Biological Assessment, A. Dale Magoun, Ph.D

Review of Appendix 14: Pondberry Biological Assessment

A. Dale Magoun, Ph.D.
Applied Research and Analysis, Inc.

COE Conclusion:

The COE has concluded that there is no relationship between variation in the density of Pondberry, an obligate wetland species, and variation in flood frequency. In other words, the abundance of Pondberry within a colony is a random feature in the BLH flood environment, where Pondberry is as abundant at sites that flood once every two years as at sites that flood only once every 100 years.

USFW Conclusion:

Contrary to the COE conclusion and rationale, the Service finds that the analysis of correlations between the densities of Pondberry plants in colonies at various sites to the current frequency of flooding at such sites is insufficient to discount any effect of flooding. More specifically, we disagree with the scope of the inferences made by which sites were selected for study, and the selection and measurement of certain parameters at these sites.

According to the COE report, fifty known Pondberry colonies within the DNF were surveyed. This is study, obviously, violates the assumption of randomness since the field team only visited locations within the DNF where Pondberry bush colonies were know to exist. Many studies arising other research areas typically violate this assumption and are referred to as quasi-random designs. Designs, such as these, still provide sufficient information for forming conclusions relative to study groups. In this study, no attempt was made to hide the fact that these were known Pondberry bush colonies. The COE used these colonies to formulate opinions about future alterations in flooding frequency. To do so, the COE measured several Pondberry bush characteristics in one of four flood frequency zones: 0-2, 2-5, 5-10, and >10. The characteristics measured in this study were the number of clumps, the number of stems, the number of dead stems, the number of female plants, numbers of mature fruit, the stem height and the average stem diameter within the colony. If there is an optimum flooding frequency, then the characteristics as measured from this survey should be optimal in that zone.

The Pondberry characteristics of number of clumps, number of stems, number of dead stems, number of females and numbers of mature fruit are represented by count data. Count data arising from biological studies, typically, are best represented by the Poisson distribution, and as such, data such as these are subjected to the square root transformation prior to any hypothesis testing. Utilizing the square root transformation stabilizes the variances and the resulting sample obeys the properties of the normal distribution. The other two characteristics of interest are stem height and average stem diameter. The data arising from these latter two characteristics do not need to be subjected to any transformations.

The primary emphasis of this survey is the effect of flooding frequency on the Pondberry bush colonies as measured by the biological characteristics mentioned in the above paragraph. According to the literature generated from this survey, the only Pondberry bush colonies surveyed were the colonies whose locations were know. No randomization appears to have occurred in this study. Designs arising in this manner are called quasi-random design and they typically arise in research areas more closely associated with psychological and educational research. As such, the model of interest is a one-way design, which assumes these characteristics are affected only by the frequency of flooding and random errors. Unless otherwise noted, the significance level for this analysis is assumed to be 0.05. Wilk's lambda, a multivariate F-test that simultaneously tests all seven Pondberry characteristics, indicates no difference among flood zones (F=1.0664, p-value=0.3857). Ancillary to this procedure individual analysis of variances (ANOVA) are performed to further substantiate this simultaneous finding. The power of the test, which measures the probability of detecting a minimum detectable difference between population means, is computed for each characteristic. The minimum detectable difference for a characteristic is taken as the difference between the characteristic's largest and smallest observable means.

Number of Clumps

Table 1 displays the summary statistics by flood zone frequency for the characteristic of number of clumps. The results of the analysis of variance indicate that differences in this characteristic among flooding zones are not present (F = 0.6494, p-value = 0.5877). The minimum detectable difference for the transformed data is 0.43774. The power, that is, the probability of being able to detect a difference of this size given the observed variation is 0.8911. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect on the number of Pondberry bush clumps.

Table 1
Number of Clumps

Zone	N	Average	Std Dev	Transformed
0-2	7	2.14	1.21	1.54640
2-5	21	4.24	3.91	1.97949
5-10	9	3.22	2.33	1.80663
>10	9	4.22	4.02	1.98414

Number of Stems

Table 2 summarizes the characteristic of number of stems per flood zone. The analysis of this data, as with the number of clumps, does not provide of enough evidence to say the flooding frequency affects the number of Pondberry bush stems within these zones (F = 1.7019, p-value = 0.1825). The power of being able to detect the minimum detectable difference of 5.5555 is 0.9852. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect on the number of Pondberry bush stems.

Table 2
Number of Stems

Zone	N	Average	Std Dev	Transformed
0-2	6	41.50	26.786	6.0949
2-5	19	216.68	412.629	10.9364
5-10	9	37.33	48.539	5.3809
>10	9	55.44	64.977	6.1551

Number of Dead Stems

Table 3 summarizes the characteristic of number of dead stems per colony within the flood zones. The analysis of this data does not provide of enough evidence to say the flooding frequency affects the number of dead Pondberry bush stems found within these zones (F = 2.7525, p-value = 0.0555). The power of being able to detect the minimum detectable difference of 2.01004 is 0.9996. If the significance level is lowered to 0.10, one could say that flooding frequency did have an effect on the number of dead Pondberry bush stems, and that the largest average number of dead stems occurred in the 2-5 year flood zone. Using the 2-5 flood zone as a control and comparing all other means with this level indicates the average number of dead stems in the 0-2 year flood zone and the 2-5 year flood zone where not different; however, the 2-5 year flood zone average is significantly larger than both the 5-10 and >10 year flood zones.

Table 3
Number of Dead Stems

Zone	N	Average	Std Dev	Transformed
0-2	6	4.00	6.197	1.67784
2-5	19	17.21	26.626	3.08060
5-10	9	1.78	3.898	1.16289
>10	9	1.11	1.692	1.07056

Number of Females

Table 4 summarizes the characteristic of number of females per flood zone. The analysis of this data does not provide of enough evidence to say that flooding frequency affects the number of female plants found in these colonies within the zones (F = 0.9450, p-value = 04267). The power of being able to detect the minimum detectable difference of 1.21515 is 0.9324. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect on the number of female plants found in the Pondberry bush colonies.

Table 4
Number of Females

Zone	N	Average	Std Dev	Transformed
0-2	6	3.80	9.402	1.38639
2-5	19	11.182	30.359	2.05413
5-10	9	2.0	4.975	1.11609
>10	9	0.556	1.333	0.83898

Numbers of mature fruit

Table 5 summarizes the characteristics of numbers of mature fruit per colony within each flood zone. The analysis of this data does not provide of enough evidence to indicate that flooding frequency affects the numbers of mature fruit found in the colonies (F = 0.7241, p-value = 0.5428). The power of being able to detect the minimum detectable difference of 2.23809 is 0.9626. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect the Pondberry bush characteristic of numbers of mature fruit.

Table 5
Numbers of Mature Fruit

Zone	N	Average	Std Dev	Transformed
0-2	6	7.10	13.254	1.86005
2-5	19	16.27	34.707	2.65281
5-10	9	45.33	119.063	3.35837
>10	9	2.44	6.966	1.12028

Stem Height

Table 6 summarizes the characteristics of stem height per flood zone. The analysis of this data, as with the preceding conclusions, does not provide of enough evidence to say that flooding frequency affects the average Pondberry stem heights found within these zones (F =

1.3596, p-value = 0.2669). The power of being able to detect the minimum detectable difference of 5.6778 is 0.9980. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect on the average stem height of Pondberry bush as observed in these zones.

Table 6
Stem Height

Zone	N	Average	Std Dev
0-2	10	22.90	6.9194
2-5	22	20.86	8.2825
5-10	9	18.00	5.3657
>10	9	17.22	5.1908

Average Stem Diameter

Table 7 summarizes the characteristic of average Pondberry bush stem diameter by flood zone. The analysis of this data does not provide of enough evidence to say that flooding frequency affects the stem diameters within these zones (F = 0.6277, p-value = 0.6008). The power of being able to detect the minimum detectable difference of 0.091603 is 0.8819. One can, thus, conclude with confidence that the data does not provide enough evidence to indicate that flooding frequency has an effect on the average Pondberry bush stem diameters.

Table 7
Average Diameter

Zone	N	Average	Std Dev
0-2	10	0.3050	0.1828
2-5	22	0.2778	0.1622
5-10	9	0.3694	0.1949
>10	9	0.3125	0.1432

Summary and Conclusions

The data, collected from this survey, reflects measurable characteristics of the Pondberry bush colonies found within the DNF. The proposed project by the COE would have the tendency to shift the flood frequency zones upward from their current levels. That is, after the proposed pumping station has been installed on the Yazoo River, a Pondberry bush colony located in the 2-5 year flood zone may be shifted to the 5-10 year flood zone, etc. Obviously, one would like to assess the impact of such a movement on the colonies; however, such an assessment can only be made after the project has been completed. As such, the best one can do is to compare the Pondberry bush characteristics at the present-day flood zone levels to see if there are any indications of healthier colonies at the different levels.

The characteristics of interest in this survey are the number of clumps, the number of stems, the number of dead stems, the number of females, the numbers of mature fruit, the stem height, and the average stem diameter. Table 8 below shows the results of the F-test used to evaluate the effects of flood zones on these characteristics. As can be seen from this table, the p-values for all tests were non-significant at the 0.05 level and that the power of these tests for detecting the minimum detectable difference as shown is extremely high.

Table 8
Summary of F-Tests

Characteristic	F-Ratio	p-value	Minimum Detectable Difference	Power
Number of Clumps	0.6494	0.5877	0.43309	0.8789
Number of Stems	1.7019	0.1825	5.55555	0.9852
Number of Dead Stems	2.7525	0.0555	2.01004	0.9996
Number of Females	0.9450	0.4267	1.21515	0.9324
Numbers of mature fruit	0.7241	0.5428	2.23809	0.9626
Stem Height	1.3596	0.2669	5.67780	0.9980
Average Stem Diameter	0.6277	0.6008	0.09160	0.8819

Thus, one can conclude with a good degree of confidence that flood frequency does not effect these characteristics, and if these characteristics a good measures of the health of the Pondberry bush colonies, then the installation of the pumping station in the Yazoo Backwater Area should not have any serious future impacts on Pondberry bush colonies.

Multivariate Studies

To further investigate the USFW claim that the analysis of correlations between the density of Pondberry plants in colonies at various sites to the current frequency of flooding at such sites is insufficient to discount any effect of flooding, an in depth multivariate exploration did not support their claim. The COE in their survey of these sites not only measured the Pondberry bush characteristics, but also measured concomitant physical variables at each of these sites. Data on percent canopy cover and the diameter breast height (DBH) of the overstory species; the percent herbaceous cover, the iron-rod elevation and the average elevations were recorded.

To assist in the interpretation of the relationship between these two sets of variables, the multivariate technique of canonical correlation analysis (CCA) was used to find linearly combinations of the variables in each set that are correlated with each other. As such, CCA indicates that the largest canonical correlation is 0.672586 and is associated with the two linear combinations of

$$V1 = -0.1924*PB1 + 1.7542*PB2 - 1.4438*PB3 - 0.8483*PB4 + 0.6134*PB5 - 0.5315*PB6 + 0.6050 * PB7$$

and

$$W1 = -3.7031*V1 + 4.1569*V2 - 0.2334*V3 + 0.0762*V4 + 0.4968*V5$$

where

PB1 = Number of clumps
PB2 = Number of stems
PB3 = Number of dead stems
PB4 = Number of females
PB5 = Numbers of mature fruit
PB6 = Stem height
PB7 = Average Diameter

V1 = Iron rod elevation
V2 = Average elevation
V3 = Percent canopy cover
V4 = DBH
V5 = Percent herbaceous cover

Note: PB1 through PB5 were transformed via the square root transformation prior to CCA.

V1 is negatively correlated with number of dead stems and stem height (-0.3484 and -0.2630, respectively) and is positively correlated with average stem diameter (0.3743). W1 is positively correlated with iron rod elevation (0.3406), average elevation (0.4817) and percent herbaceous cover (0.5041). The second canonical correlation for this data is 0.42772. The linear combinations that exhibit this correlation are:

$$V2 = 0.2255*PB1 - 0.4301*PB2 + 0.2496*PB3 - 0.3701*PB4 - 0.5549*PB5 + 0.0529*PB6 + 0.4739*PB7$$

and

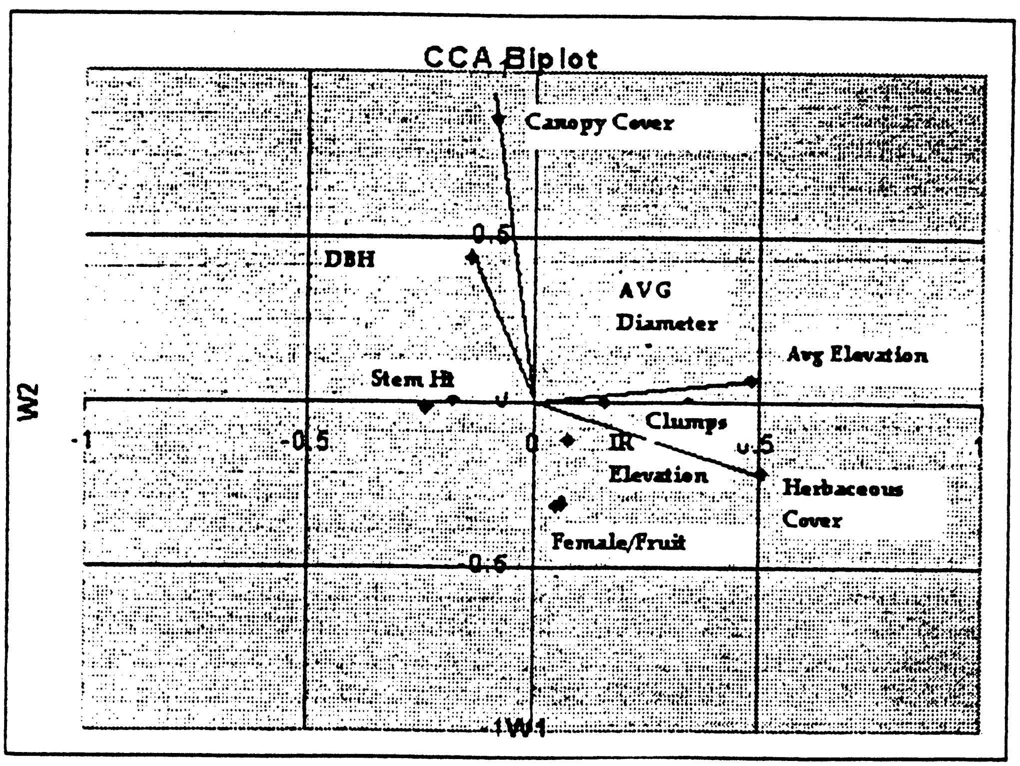
$$W2 = -1.5353*V1 + 1.4156*V2 + 0.8366*V3 + 0.38889*V4 - 0.0787*V5$$

V2 is negatively correlated with number of females (-0.7220) and numbers of mature fruits (-0.7322) and positively correlated with average stem diameter (0.4569). W2 is positively correlated with percent canopy cover (0.8607) and DBH (0.4386) and is negatively correlated with percent herbaceous cover (-0.2123). A biplot describing the relationships is given in Figure 1. W1 axis represents an elevation and ground cover gradient; whereas, W2 represents an overstory gradient. Using these gradients, one can surmise that in areas with less canopy cover and overstory species with smaller DBH measurements more female and fruit was observed;

whereas, as sites, where the overstory species dominate, are associated with Pondberry bush colonies with the largest average diameters. On the elevation gradient, stem heights appears to be associated with sites that are lower in elevation; whereas, number of clumps and number of stems tends to be associated with sites in higher elevation more herbaceous zones.

In summary, changes in elevation and changes in other ground cover species tend to affect different Pondberry bush characteristics, but not the occurrence of Pondberry bush colonies. Pondberry colonies occur in all elevation zones, and as such, it appears that the characteristics that describe the colonies tend to change. Whether it is a change in stem height to colonies with more clumps and stems or to changes in colonies that have more feminine characteristics to colonies with thick stem diameters is dependent on the gradient changes observed. What is apparent is that elevation and overstory characteristics joint effect Pondberry colonies, and that these effects are not detrimental, but are changes that effect changes in characteristics of the colonies.

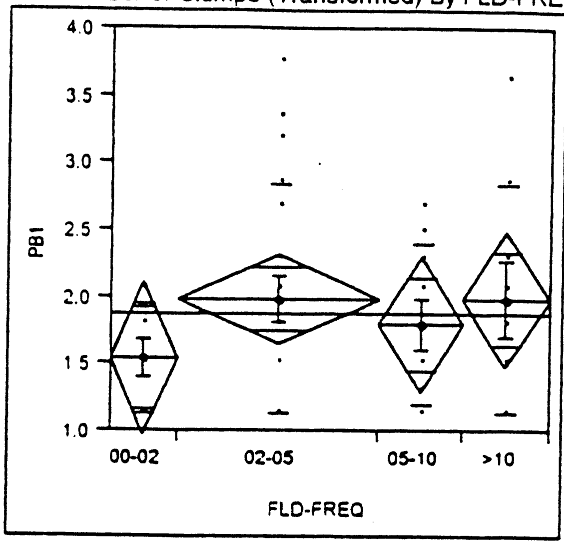
Figure1
W1 vs. W2
Biplot



Appendix I
Output: Analyses of Variances

Appendix II
Output: Canonical Correlation Analysis

PB1: Number of Clumps (Transformed) By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.044332
RSquare Adj	-0.02393
Root Mean Square Error	0.762999
Mean of Response	1.880476
Observations (or Sum Wgts)	46

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	1.134244	0.378081	0.6494
Error	42	24.451019	0.582167	Prob>F
C Total	45	25.585263	0.568561	0.5877

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	7	1.54640	0.28839
02-05	21	1.97949	0.16650
05-10	9	1.80563	0.25433
>10	9	1.98414	0.25433

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

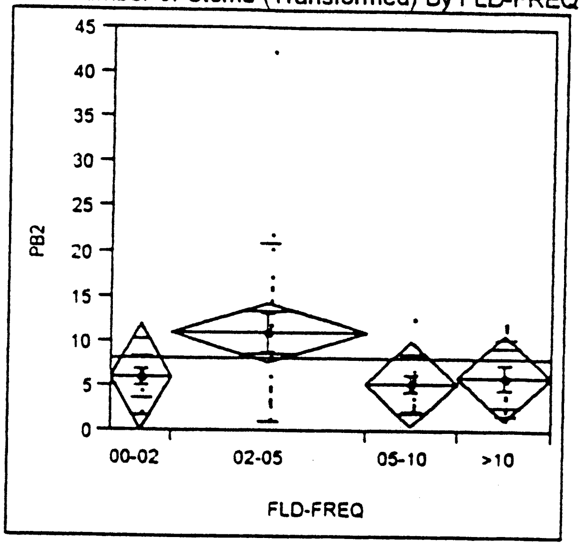
Power

Alpha	Sigma	Delta	Number	Power
0.0500	0.762999	0.157027	46	0.1746
0.0500	0.762999	0.43774	46	0.8911

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	7	1.54640	0.384172	0.14520
02-05	21	1.97949	0.854087	0.18638
05-10	9	1.80563	0.615670	0.20522
>10	9	1.98414	0.861961	0.28732

PB2: Number of Stems (Transformed) By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.115758
RSquare Adj	0.047739
Root Mean Square Error	7.373224
Mean of Response	8.097303
Observations (or Sum Wgts)	43

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	277.5605	92.5202	1.7019
Error	39	2120.2131	54.3644	Prob>F
C Total	42	2397.7736	57.0898	0.1825

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	6	6.0949	3.0101
02-05	19	10.9364	1.6915
05-10	9	5.3809	2.4577
>10	9	6.1551	2.4577

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

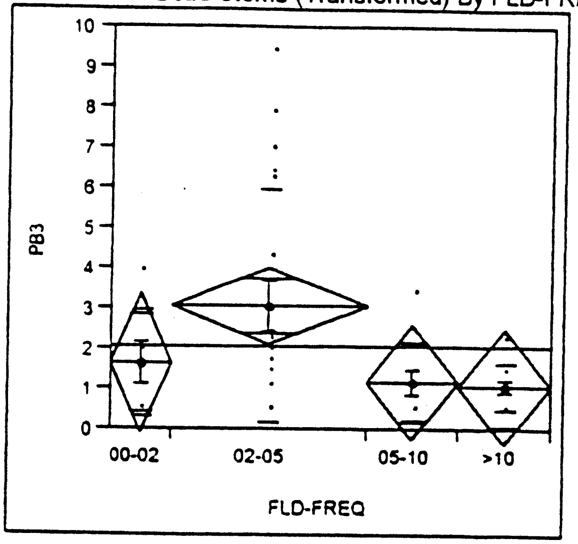
Power

Alpha	Sigma	Delta	Number	Power
0.0500	7.373224	2.540649	43	0.4100
0.0500	7.373224	5.5555	43	0.9852

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	6	6.0949	2.3816	0.9723
02-05	19	10.9364	10.1425	2.3268
05-10	9	5.3809	3.1383	1.0461
>10	9	6.1551	4.4918	1.4973

PB3: Number of Dead Stems (Transformed) By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.174732
RSquare Adj	0.11125
Root Mean Square Error	2.10881
Mean of Response	2.062781
Observations (or Sum Wgts)	43

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	36.72116	12.2404	2.7525
Error	39	173.43605	4.4471	Prob>F
C Total	42	210.15721	5.0037	0.0555

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	6	1.67784	0.86092
02-05	19	3.08060	0.48379
05-10	9	1.16289	0.70294
>10	9	1.07056	0.70294

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

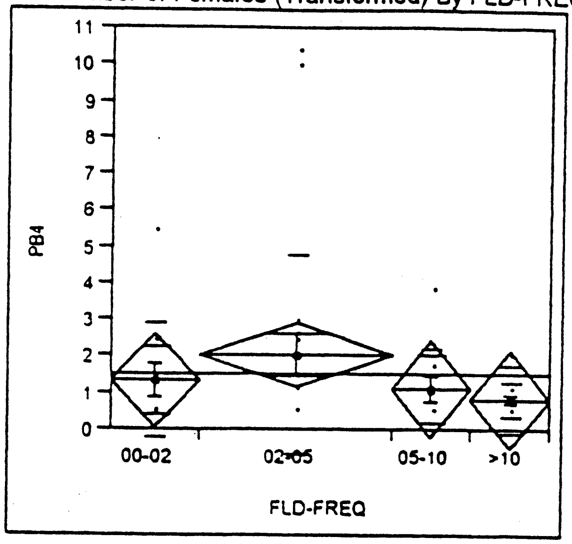
Power

Alpha	Sigma	Delta	Number	Power
0.0500	2.10881	0.924111	43	0.6209
0.0500	2.10881	2.01004	43	0.9996

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	6	1.67784	1.36815	0.55855
02-05	19	3.08060	2.92321	0.67063
05-10	9	1.16289	0.94896	0.31632
>10	9	1.07056	0.61847	0.20616

PB4: Number of Females (Transformed) By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.058052
RSquare Adj	-0.00338
Root Mean Square Error	2.065003
Mean of Response	1.533012
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	12.08895	4.02965	0.9450
Error	46	196.15484	4.26424	Prob>F
C Total	49	208.24379	4.24987	0.4267

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	10	1.38639	0.65301
02-05	22	2.05413	0.44026
05-10	9	1.11609	0.68833
>10	9	0.83898	0.68833

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

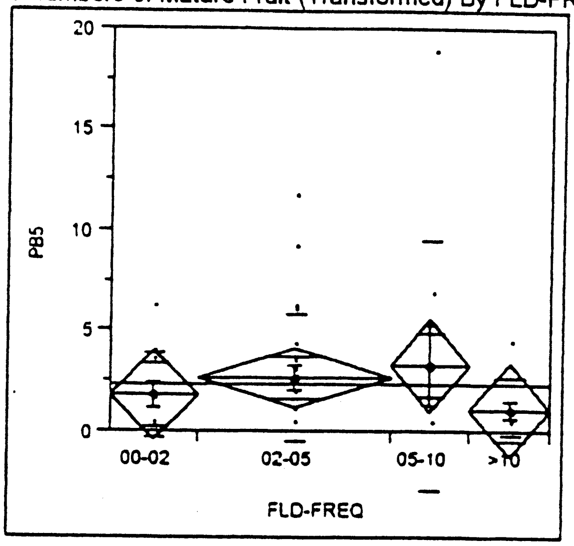
Power

Alpha	Sigma	Delta	Number	Power
0.0500	2.065003	0.49171	50	0.2418
0.0500	2.065003	1.21515	50	0.9324

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	10	1.38639	1.58216	0.50032
02-05	22	2.05413	2.77250	0.59110
05-10	9	1.11609	1.12717	0.37572
>10	9	0.83898	0.50497	0.16832

PB5: Numbers of Mature Fruit (Transformed) By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.045094
RSquare Adj	-0.01718
Root Mean Square Error	3.537149
Mean of Response	2.345406
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	27.17802	9.0593	0.7241
Error	46	575.52549	12.5114	Prob>F
C Total	49	602.70352	12.3001	0.5428

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	10	1.86005	1.1185
02-05	22	2.65281	0.7541
05-10	9	3.35837	1.1790
>10	9	1.12028	1.1790

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

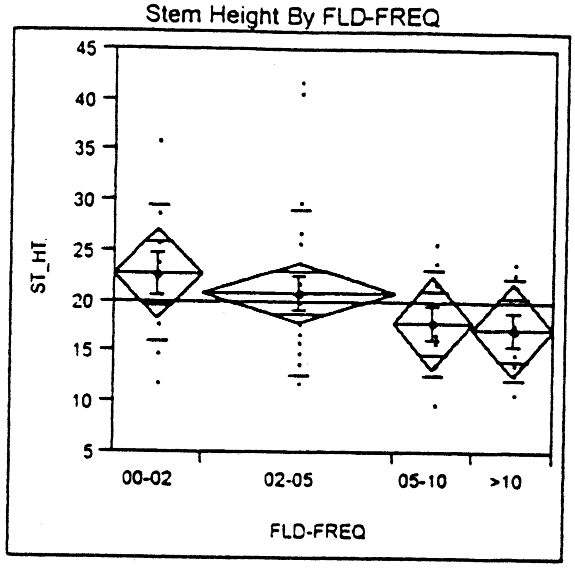
Power

Alpha	Sigma	Delta	Number	Power
0.0500	3.537149	0.737266	50	0.1921
0.0500	3.537149	2.23809	50	0.9626

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	10	1.86005	2.11219	0.6679
02-05	22	2.65281	3.17300	0.6765
05-10	9	3.35837	6.22361	2.0745
>10	9	1.12028	1.32664	0.4422

Stem Height By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.081448
RSquare Adj	0.021543
Root Mean Square Error	7.097223
Mean of Response	20.1
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	205.4535	68.4845	1.3596
Error	46	2317.0465	50.3706	Prob>F
C Total	49	2522.5000	51.4796	0.2669

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	10	22.9000	2.2443
02-05	22	20.8636	1.5131
05-10	9	18.0000	2.3657
>10	9	17.2222	2.3657

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

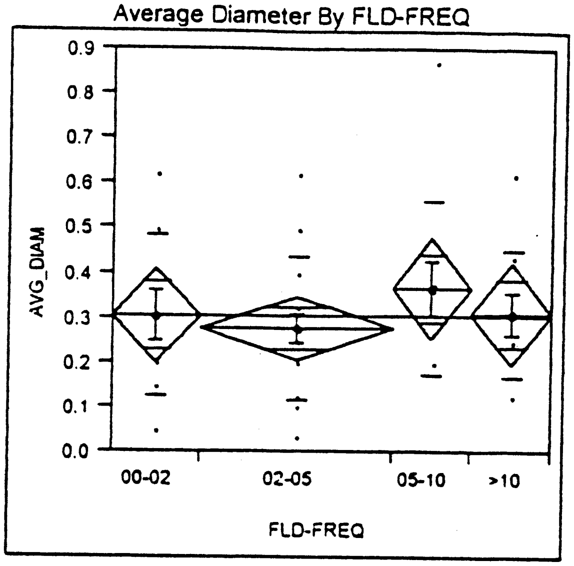
Power

Alpha	Sigma	Delta	Number	Power
0.0500	7.097223	2.027084	50	0.3376
0.0500	7.097223	5.6778	50	0.9980

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	10	22.9000	6.91938	2.1881
02-05	22	20.8636	8.28249	1.7658
05-10	9	18.0000	5.36190	1.7873
>10	9	17.2222	5.19080	1.7303

Average Diameter By FLD-FREQ



Oneway Anova

Summary of Fit

RSquare	0.039324
RSquare Adj	-0.02333
Root Mean Square Error	0.169443
Mean of Response	0.306
Observations (or Sum Wgts)	50

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	0.0540616	0.018021	0.6277
Error	46	1.3207009	0.028711	Prob>F
C Total	49	1.3747625	0.028056	0.6008

Means for Oneway Anova

Level	Number	Mean	Std Error
00-02	10	0.305000	0.05358
02-05	22	0.277841	0.03613
05-10	9	0.369444	0.05648
>10	9	0.312500	0.05648

Std Error uses a pooled estimate of error variance

Power Details

Test 1-way Anova

Power

Alpha	Sigma	Delta	Number	Power
0.0500	0.169443	0.032882	50	0.1709
0.0500	0.169443	0.091603	50	0.8819

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
00-02	10	0.305000	0.182783	0.05780
02-05	22	0.277841	0.162153	0.03457
05-10	9	0.369444	0.194867	0.06496
>10	9	0.312500	0.143205	0.04774

Canonical Correlation Analysis

	Canonical Correlation	Adjusted Canonical Correlation	Approx Standard Error	Squared Canonical Correlation
1	0.672586	0.561435	0.085525	0.452372
2	0.427772	.	0.127596	0.182989
3	0.419766	.	0.128655	0.176204
4	0.266064	0.198148	0.145118	0.070790
5	0.015098	-1.59116	0.156138	0.000228

Eigenvalues of INV(E)*H
= CanRsq/(1-CanRsq)

	Eigenvalue	Difference	Proportion	Cumulative
1	0.8261	0.6021	0.6163	0.6163
2	0.2240	0.0101	0.1671	0.7834
3	0.2139	0.1377	0.1596	0.9430
4	0.0762	0.0760	0.0568	0.9998
5	0.0002	.	0.0002	1.0000

Test of H0: The canonical correlations in the current row and all that follow are zero

	Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
1	0.34241116	1.0664	35	128.6284	0.3857
2	0.62526263	0.6565	24	109.3561	0.8823
3	0.76530526	0.6019	15	88.73931	0.8661
4	0.92899798	0.3095	8	66	0.9599
5	0.99977205	0.0026	3	34	0.9998

Multivariate Statistics and F Approximations

S=5 M=0.5 N=14

Statistic	Value	F	Num DF	Den DF	Pr > F
Wilks' Lambda	0.34241116	1.0664	35	128.6284	0.3857
Pillai's Trace	0.88258319	1.0411	35	170	0.4162
Hotelling-Lawley Trace	1.34033537	1.0876	35	142	0.3557
Roy's Greatest Root	0.82605798	4.0123	7	34	0.0027

NOTE: F Statistic for Roy's Greatest Root is an upper bound.

Canonical Correlation Analysis

Raw Canonical Coefficients for the 'VAR' Variables

	V1	V2	
PB1	-0.252380703	0.2957888058	Number of Clumps
PB2	0.2307197508	-0.056568726	Number of Stems
PB3	-0.640987177	0.1108272126	Number of Dead Stems
PB4	-0.532905759	-0.232489306	Number of Females
PB5	0.1826071343	-0.165209688	Numbers of Fruit
PB6	-0.105623955	0.0105198291	Stem Height
PB7	3.43863565	2.6933825146	AVG Diameter

Raw Canonical Coefficients for the 'WITH' Variables

	W1	W2	
V1	-1.819681666	-0.754439546	Iron Rod Elevation
V2	1.936462795	0.6594373911	Average Elevation
V3	-0.034688288	0.124354613	Percent Canopy Cover
V4	0.0122625005	0.0625642303	DBH
V5	0.0176085988	-0.002788325	Percent Herbaceous Cover

Standardized Canonical Coefficients for the 'VAR' Variables

	V1	V2	
PB1	-0.1924	0.2255	Number of Clumps
PB2	1.7542	-0.4301	Number of Stems
PB3	-1.4438	0.2496	Number of Dead Stems
PB4	-0.8483	-0.3701	Number of Females
PB5	0.6134	-0.5549	Numbers of Fruit
PB6	-0.5315	0.0529	Stem Height
PB7	0.6050	0.4739	AVG Diameter

Standardized Canonical Coefficients for the 'WITH' Variables

	W1	W2	
V1	-3.7031	-1.5353	Iron Rod Elevation
V2	4.1569	1.4156	Average Elevation
V3	-0.2334	0.8366	Percent Canopy Cover
V4	0.0762	0.3889	DBH
V5	0.4968	-0.0787	Percent Herbaceous Cover

Canonical Structure

Correlations Between the 'VAR' Variables and Their Canonical Variables

	V1	V2	
PB1	0.2361	0.0003	Number of Clumps
PB2	0.1201	-0.2725	Number of Stems
PB3	-0.3484	-0.0328	Number of Dead Stems
PB4	0.0961	-0.7220	Number of Females
PB5	0.0766	-0.7322	Numbers of Fruit
PB6	-0.2630	0.0169	Stem Height
PB7	0.3743	0.4569	AVG Diameter

Correlations Between the 'WITH' Variables and Their Canonical Variables

	W1	W2	
V1	0.3406	0.0006	Iron Rod Elevation
V2	0.4817	0.0662	Average Elevation
V3	-0.0802	0.8607	Percent Canopy Cover
V4	-0.1342	0.4386	DBH
V5	0.5041	-0.2123	Percent Herbaceous Cover

Correlations Between the 'VAR' Variables and the Canonical Variables of the 'WITH' Variables

	W1	W2	
PB1	0.1588	0.0001	Number of Clumps
PB2	0.0808	-0.1166	Number of Stems
PB3	-0.2343	-0.0141	Number of Dead Stems
PB4	0.0646	-0.3088	Number of Females
PB5	0.0515	-0.3132	Numbers of Fruit
PB6	-0.1769	0.0072	Stem Height
PB7	0.2518	0.1954	AVG Diameter

Correlations Between the 'WITH' Variables and the Canonical Variables of the 'VAR' Variables

	V1	V2	
V1	0.2291	0.0002	Iron Rod Elevation
V2	0.3240	0.0283	Average Elevation
V3	-0.0540	0.3682	Percent Canopy Cover
V4	-0.0903	0.1876	DBH
V5	0.3390	-0.0908	Percent Herbaceous Cover

Review of Appendix 14: Pondberry Biological Assessment

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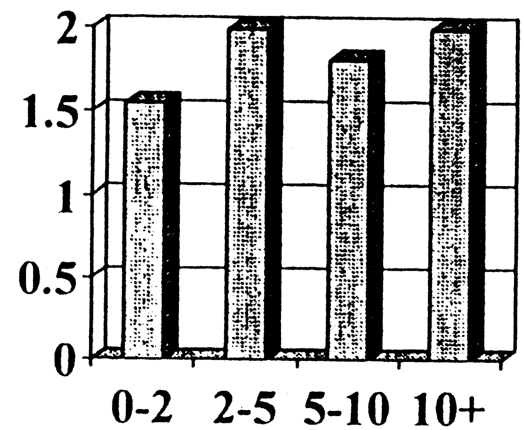
Number of Clumps

- ANOVA
  - F = 0.6494
  - P-value = 0.5877
  - Power = 0.8911
  - Min Det Diff = 0.43774
- Means and St Dev

Fld Freq	N	Ave	STD	Trans. Mean
0-2	7	2.14	1.21	1.54640
2-5	21	4.24	3.91	1.97949
5-10	9	3.22	2.33	1.80663
10+	9	4.22	4.02	1.98414

Average Number of Clumps(Transformed)



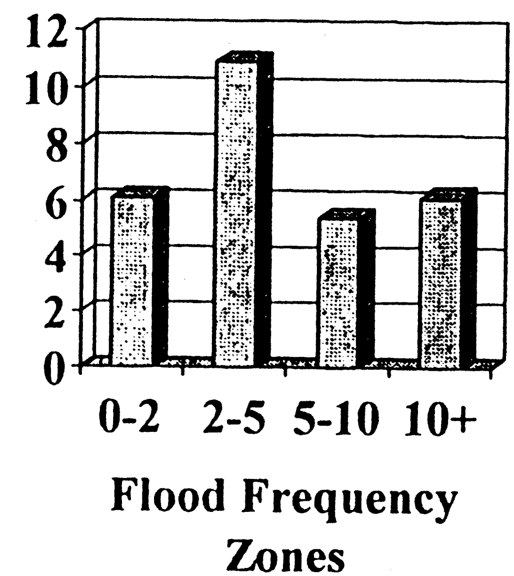
Flood Frequency Zones

Number of Stems

- ANOVA
  - $F = 1.7019$
  - P-value = 0.1825
  - Power = 0.9852
  - Min Det Diff = 5.5555
- Means and St Dev

Fld Freq	N	Ave	STD	Trans Mean
0-2	6	41.50	26.786	6.09549
2-5	19	216.68	412.629	10.9364
5-10	9	37.33	48.539	5.3809
10+	9	55.44	64.977	6.1551

Average Number of Stems (Transformed)

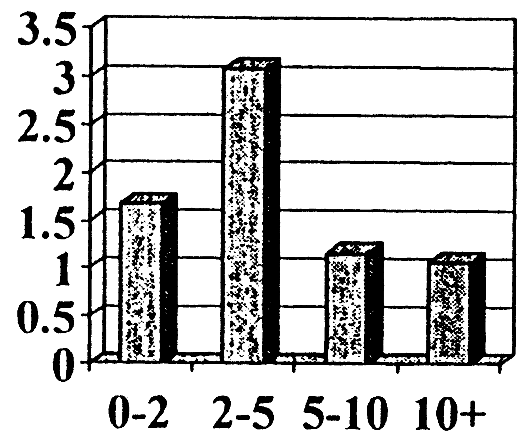


Number of Dead Stems

- ANOVA
  - F = 2.7525
  - P-value = 0.0555
  - Power = 0.9996
  - Min Det Diff = 2.01004
- Means and St Dev

Fld Freq	N	Ave	STD	Trans Mean
0-2	6	4.00	6.197	1.67784
2-5	19	17.21	26.626	3.08060
5-10	9	1.78	3.898	1.16289
10+	9	1.11	1.692	1.07056

Average Number of Dead Stems (Transformed)



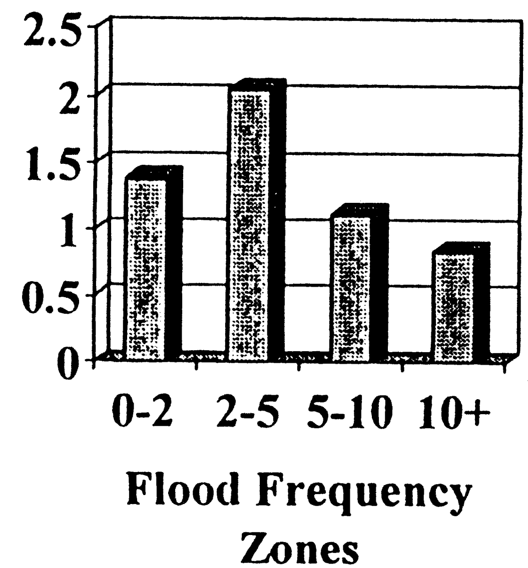
Flood Frequency Zones

Number of Females

- ANOVA
  - F = 0.9450
  - P-value = 0.4267
  - Power = 0.9324
  - Min Det Diff = 1.21515
- Means and St Dev

Fld Freq	N	Ave	STD	Trans Mean
0-2	6	3.80	9.402	1.38639
2-5	19	11.182	30.359	2.05413
5-10	9	2.00	4.975	1.11609
10+	9	0.556	1.333	0.83898

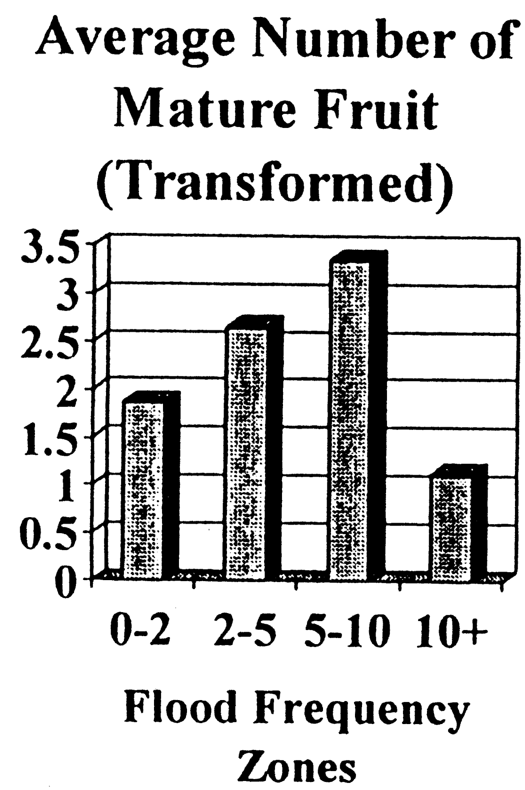
Average Number of Females (Transformed)



Number of Mature Fruit

- ANOVA
  - F = 0.7241
  - P-value = 0.5428
  - Power = 0.9626
  - Min Det Diff = 2.23809
- Means and St Dev

Fld Freq	N	Ave	STD	Trans Mean
0-2	6	7.10	13.254	1.86005
2-5	19	16.27	34.707	2.65281
5-10	9	45.33	119.063	3.35837
10+	9	2.44	6.966	1.12028

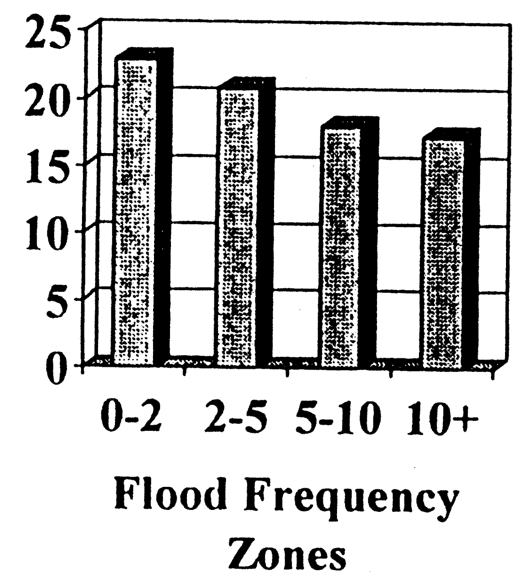


Stem Height

- ANOVA
  - F = 1.3596
  - P-value = 0.2669
  - Power = 0.9980
  - Min Det Diff = 5.6778
- Means and St Dev

Fld Freq	N	Ave	STD
0-2	10	22.90	6.9194
2-5	22	20.86	8.2825
5-10	9	18.00	5.3657
10+	9	17.22	5.1908

Average Stem Height

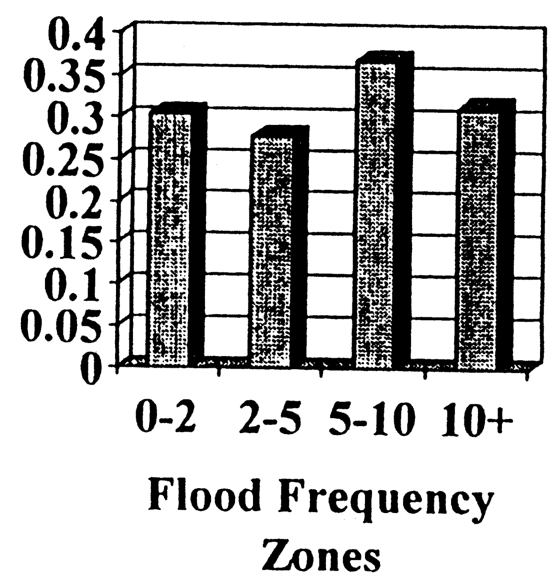


Stem Diameter

- ANOVA
  - F = 0.6277
  - P-value = 0.6008
  - Power = 0.8819
  - Min Det Diff = 0.091603
- Means and St Dev

Fld Freq	N	Ave	STD
0-2	10	0.3050	0.1828
2-5	22	0.2778	0.1622
5-10	9	0.3694	0.1949
10+	9	0.3125	0.1432

Average Stem Diameter

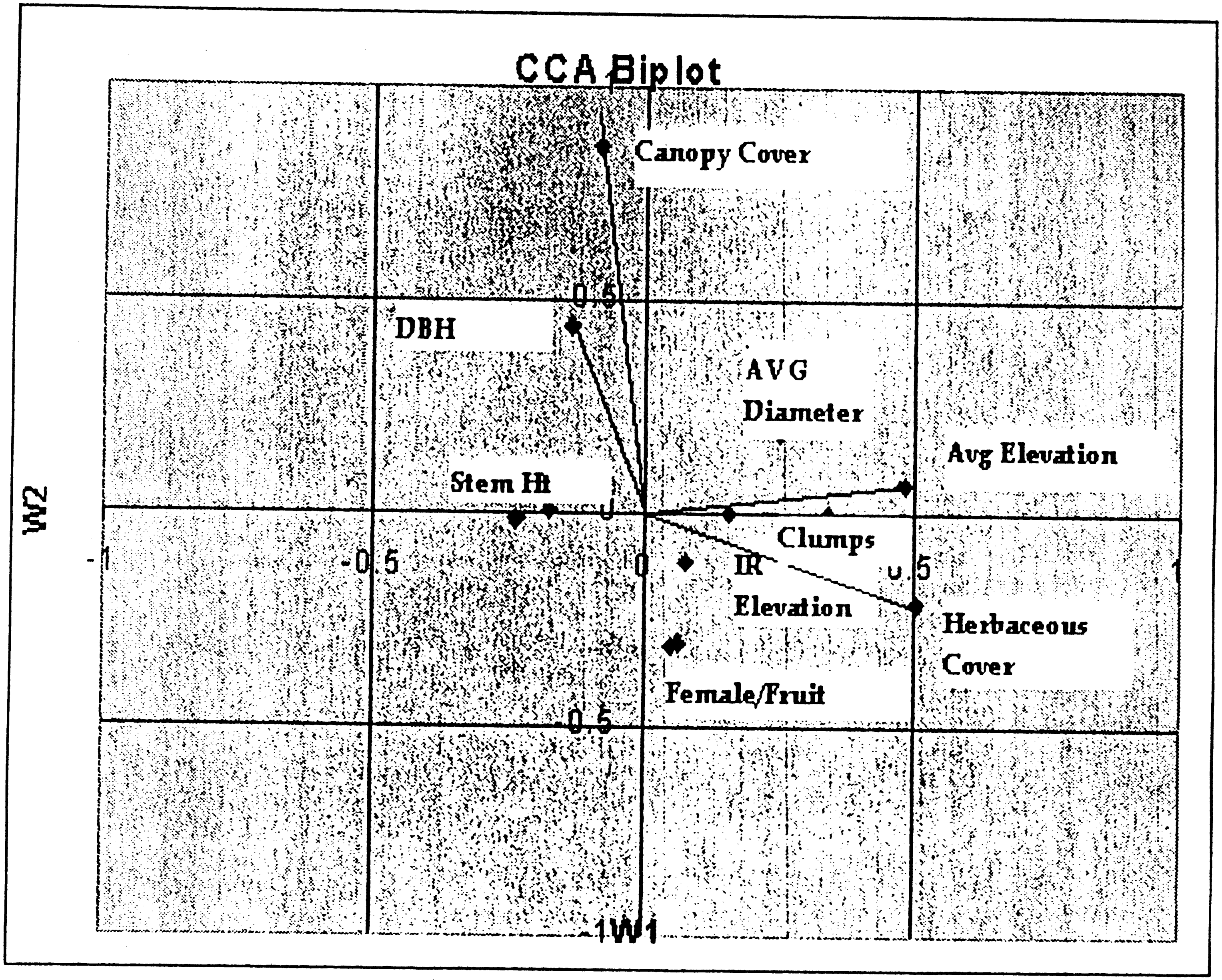


Summary of F-Tests

Characteristic	F-Ratio	P-value	Minimum Detectable Difference		Power
			Transformed	Actual Difference	
Number of Clumps	0.6494	0.5877	0.43309	0.1876	0.8789
Number of Stems	1.7019	0.1825	5.55555	30.8641	0.9852
Number of Dead Stems	2.7525	0.0555	2.01004	4.0402	0.9996
Number of Females	0.9450	0.4267	1.21515	1.4766	0.9324
Numbers of Mature Fruit	0.7241	0.5428	2.23809	5.0090	0.9626
Stem Height	1.3596	0.2669		6.678	0.9980
Stem Diameter	0.6277	0.6008		0.092	0.8819

Correlation Coefficients Between Pondberry Bush Characteristic and Distance From Water

Characteristic	Correlation with Distance From Water
Number of Clumps	-0.1685
Number of Stems	-0.2374
Number of Dead Stems	-0.1648
Number of Females	0.1470
Number of Mature Fruit	0.2347
Stem Height	0.0175
Stem Diameter	-0.0894


CCA Biplot
Canopy Cover
DBH
AVG
Diameter
Avg Elevation
Stem Ht
Clumps
IR
Elevation
Herbaceous
Cover
Female/Fruit
W2
W1
-1
-0.5
0
0.5
1

Summary and Conclusions

- Frequency of flooding as measured by the flood frequency zones of 0-2 years, 2-5 years, 5-10 years, and more than 10 years did not adversely effect the characteristics of number of clumps, number of stems, number of dead stems, number of females, number of mature fruit, stem height, and stem diameter as measured on the Pondberry bush colonies studied in the DNF.
- There appears to be no meaningful correlation between distance from water and the Pondberry bush characteristics measured in this study.
- Changes in elevation, ground cover and overstory species appear to effect different characteristics of the Pondberry, but not the occurrence of Pondberry.
  - Colonies tend to be associated with areas with less canopy cover and overstory species with smaller DBH.
  - Colonies with more fruit are also associated with areas with less canopy cover and overstory species with smaller DBH.
  - Colonies with larger stem diameters tend to be associated with areas with more canopy cover and overstory species with larger DBH.
  - Colonies with larger stem heights tend to be associated with areas that are lower in elevation.
  - Colonies that are characterized by more clumping and more stems tend to be associated with areas that are higher in elevation.

Appendix D
Independent Review of Pondberry Data
Dr. Dale Magoun 2001

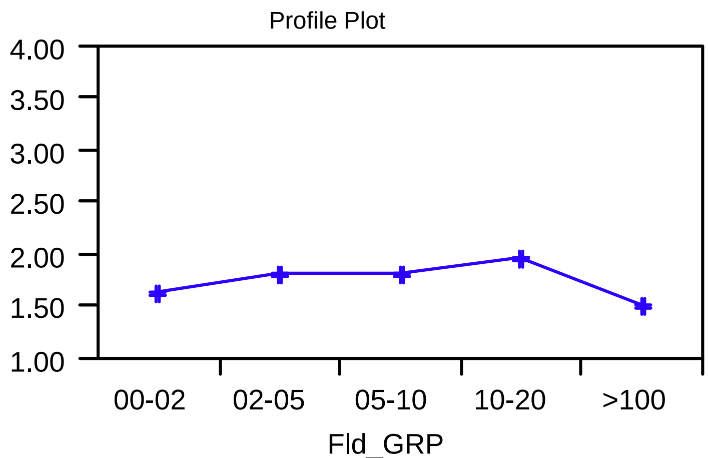
Response: Number of Clumps
Transformation: Square Root

Root Mean Square Error	0.721273
Mean of Response	1.787729
Observations (or Sum Wgts)	62

Effect Test

Source	DF	Sum of Squares	F Ratio	Prob>F
Flood Frequency Group	4	1.4460972	0.6949	0.5986

Flood Frequency Group
Based on Big Sunflower Gauge



Level	Least Sq Mean	Std Error	Mean
00-02	1.649660984	0.3225632952	1.64966
02-05	1.835585934	0.1749345083	1.83559
05-10	1.841246465	0.1700057837	1.84125
10-20	1.994888132	0.2280866934	1.99489
>100	1.524552063	0.2082137117	1.52455

Power Details

Alpha	Sigma	Delta	Number	Power
0.0500	0.721273	0.25	62	0.5305
0.0500	0.721273	0.5	62	0.9942
0.0500	0.721273	0.75	62	1.0000
0.0500	0.721273	1	62	1.0000

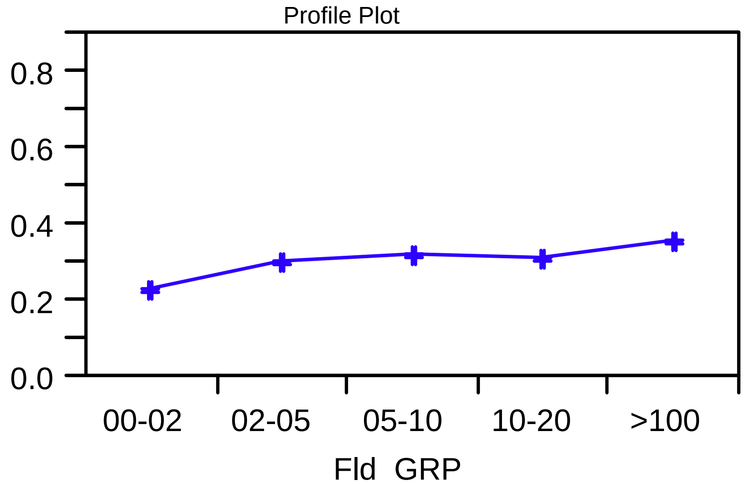
Response: Average Stem Diameter

Root Mean Square Error	0.173539
Mean of Response	0.315524
Observations (or Sum Wgts)	62

Effect Test

Source	DF	Sum of Squares	F Ratio	Prob>F
Flood Frequency Group	4	0.05518444	0.4581	0.7661

Flood Frequency
Based on Big Sunflower Gauge



Level	Least Sq Mean	Std Error	Mean
00-02	0.2350000000	0.0776088318	0.235000
02-05	0.3036764706	0.0420892985	0.303676
05-10	0.3243055556	0.0409034458	0.324306
10-20	0.3125000000	0.0548777312	0.312500
>100	0.3552083333	0.0500962855	0.355208

Power Details

Alpha	Sigma	Delta	Number	Power
0.0500	0.173539	0.075	62	0.7472
0.0500	0.173539	0.1	62	0.9540
0.0500	0.173539	0.125	62	0.9968
0.0500	0.173539	0.15	62	0.9999
0.0500	0.173539	0.175	62	1.0000